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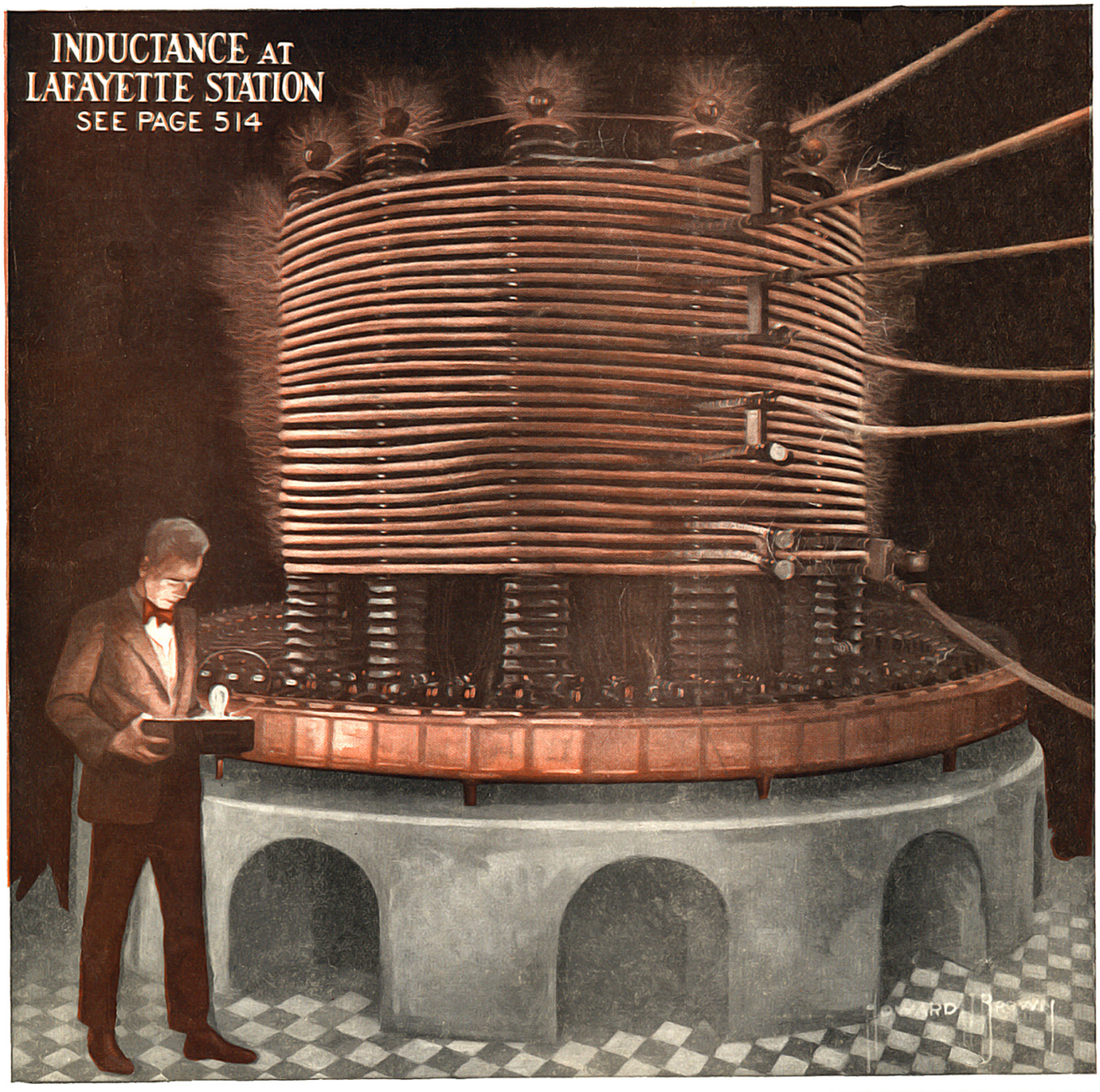

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RADIO NEWS

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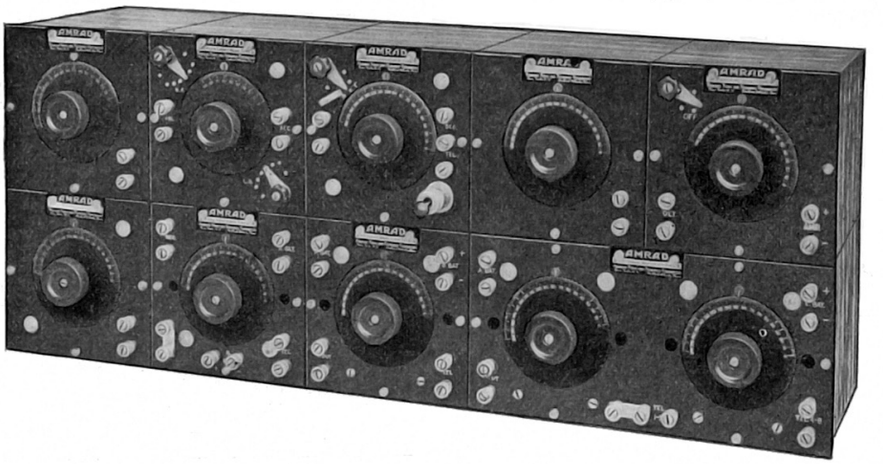

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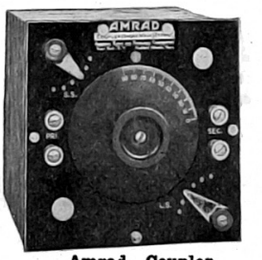

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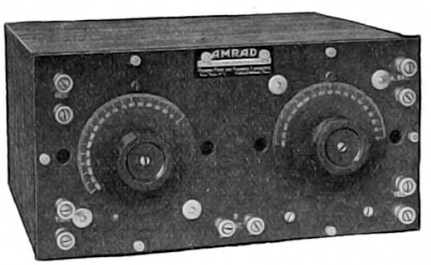

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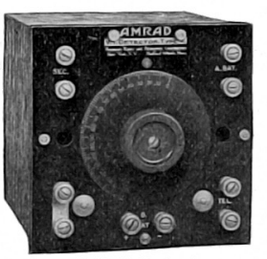

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RADIO NEWS

H. GERNSBACK—Editor
ROBERT E. LACAULT—Associate Editor

Vol. 2 FEBRUARY, 1921 No. 8

WHAT IS COMING

NOT so long ago a number of manufacturers of radio instruments met at a certain hotel in New York City and talked shop. All of these men have had long experience in the radio field, having built radio apparatus for many years. They are all successful men in their lines. As the talk progresst, it became apparent that they were not at all satisfied with the radio business as a whole. They seemed to be of the opinion—and rightly so—that selling radio apparatus is a fickle undertaking. They thot that there was too much change of style in the various instruments, and as the radio amateur is notoriously fickle in buying everything of the latest and newest, it happens not infrequently that a well-meaning manufacturer becomes loaded with unsaleable material which moves no longer, due to the newer designs on the market.

The radio business, it was the concensus of these men, is worse than selling women's dresses or men's straw hats, with the difference that the radio business is perhaps more uncertain. There is always a market for women's dresses and straw hats for men, even tho out of season, but for antiquated radio instruments there is little or no demand, and frequently such apparata become a total loss to the man who manufactures or sells them.

It was always thus in the radio business, ever since its inception. The writer well remembers the days of the coherer when a New York manufacturer used to turn them out by the thousands. Suddenly the electrolytic detector sprung up and overnight the coherer went out of business. He could not sell these coherers any longer, as a matter of fact, he could not even give them away.

The same fate met the manufacturer of the electrolytic detector when the crystal detector suddenly came into vogue. He had left on his hands a great many thousands of electrolytic detectors, not mentioning the many thousand parts which go into the making of them. Examples such as these might be quoted indefinitely, and if the manufacturer does not lose out, it often happens that the dealer must bear the loss. Frequently it becomes necessary for him to dispose of antiquated radio apparatus at a price much below what he originally paid.

What is the remedy? Apparently none as far as we can see. The amateur—the ultimate consumer—certainly cannot be blamed for only wishing to buy the very latest and the most up-to-date. You cannot expect him to invest ten dollars in a long wave loading coil that stands six feet high, when he can get the same result with a little concentrated inductance that costs about two dollars. He is not at all concerned that the manufacturer of the aforesaid loading coil may have lost a thousand dollars in the transaction because he has a young carloadful of woodwork on his hands, as well as forms and dies formerly used to make those coils.

It seems to be the penalty of any young art that things take precisely such a turn as pictured here. It was thus in the photographic business when it was young. Until the trade became pretty well establisht there was no end of styles and no end of changes, and many manufacturers lost a fortune in these transactions. But the art seems to work out its own salvation as always happens.

At the aforementioned meeting, the writer ventured the prediction that the radio business would in time settle down into much the sames lines as the photographic business today. The chances are that during the next decade, most of the radio apparata will be sold by all up-to-date drug stores, the same as photographic cameras and supplies are now. By that time a radio receiving outfit will have been compresst into a space as small as the present-day cameras, pocket cameras not excepted. These outfits will comprise a one- or two-step amplifier, and there will be no fones with such an outfit, but very likely the sounds will come right from a horn similar to our phonograph today, only built along miniature lines. The aerial will probably be of the loop type, collapsible, and made to fit right into the box itself. Such a loop aerial could be extended into its full shape within a few seconds. The vacuum tubes used in the outfit will possibly be even smaller than the ones made now, and described in these columns not so long ago. These vacuum tubes are about the thickness of a fountain pen and are from one to one and one-half inches long. There is no doubt that in time vacuum tubes will be made even smaller.

We have often mentioned in these columns that the small outfit is *the* thing, and we cannot urge manufacturers too much to pay attention to this phase. Amateurs want compact apparatus these days, particularly for receiving. The radio amateur today is considered more or less in the crank class, exactly as the amateur photographer was considered a crank thirty-five or forty years ago. When you can take a neat little box fashioned along the lines of a kodak, set it up in your parlor, and when dance music, originated some five hundred miles distant, begins to pour forth from it by radio, then we can truly say that the hey-day of amateur radio has really arrived. If anyone is incredulous as to the small outfit, the reader's attention is called to our December issue where the first prize was won by a young man who constructed a most marvelously small radio outfit that actually fits into the pocket. That is exactly what we are coming to, and the manufacturer who sees the wonderful possibilities of such a thing first, will do much towards standardizing amateur radio apparatus.

Of course, the large apparatus will probably always be with us, the same as the large photographic camera is with us today. There will always be large apparata for the laboratory, but they are distinct from the popular apparata, mentioned above.

What can be accomplisht in receiving outfits can also be achieved in sending outfits. It is not at all impossible that we will have a small outfit less than a foot square for sending radiofone messages. As a matter of fact, it has been accomplisht already in an experimental way. With the vacuum tube for sending purposes and with a few dry cells or a concentrated storage battery, much that was thot impossible is a reality today. It is simply a matter of designing the apparatus correctly, and taking advantage of every bit of room at hand, just exactly as the portable camera people have been doing so successfully for many years. The battle cry for the next decade should be small portable outfits, the smaller the better. There is no doubt that many fortunes will be made from them.

H. GERNSBACK.

The Lafayette Radio Station

By the Paris Correspondent of Radio News

General View of the Lafayette Station Erected at Bordeaux, France. The Eight 835-Foot Towers Were Furnisht and Erected by the American Navy. Note the Building in the Background.

THE Lafayette Radio Station which is erected at Croix D'Hins, near Bordeaux, France, was built by collaboration of the American Navy, and the French Signal Corps, whose well-known chief is General Ferrié. This station, which is actually the most powerful in the world, started its regular service on November 15th, 1920, and great credit must be given to those who conceived and built it. It will remain as another material proof of the Franco-American friendship.

We shall first give a short historical notice on the construction of the station, a description of its different parts, and end by giving the very interesting results obtained up until the present. We shall also discuss the important rôle to be played by this powerful radio station in the future.

Since it was sure at the beginning of 1917 that the U. S. would fight with France, the necessity of a constant radio liaison between the two countries was felt. Cables could be cut by the German submarines, and only radio communication seemed to be safe against any enemy enterprise. The two biggest radio stations in existence in France, immediately started some tests with the American stations. These two powerful radio stations were the Eiffel Tower in Paris, and La Doua Radio near Lyon; Poulsen arcs delivering 40 kilowatts in the aerial were used. The Lyon station gave a better reception, owing to its aerial which was erected in the direction of the United States. During the spring months, the reception of Lyon was as good as Nauen on this side of the Atlantic, but in the summer time, the statics were so strong that it was practically impossible to receive any messages. Even the German stations which used more power had much trouble to secure constant communication.

Since it was necessary to insure liaison between the two countries, General Ferrié offered two solutions: one, to immediately raise the Lyon Towers, which were only 400 feet high, to a height of 670 feet; the other one, which required much more time, was the construction of an ultra-powerful station, delivering 500 kilowatts in the aerial. The aerial was to be of the inverted L type, supported by eight 835-foot towers. The characteristics given in September, 1917, are those of the actual station today. At the same time it was decided to raise the towers of the Lyon station. As a consequence of this the Franco-American relations were possible in 1918. As soon as the summer came, communication was almost constant, and a great number of telegrams could be sent during the static-less hours of the day.

At the end of 1917, when the construction of the Lafayette station was decided, General Pershing asked for a station that could communicate with the U. S. at any hour of the day and in any season. It was, therefore, necessary to erect the big station General Ferrié had urged since September. At a meeting of the most prominent radio engineers of the two countries, it was decided that the station would be erected in France, near Bordeaux, and fitted with the most powerful apparatus that could be built at that time. This station, which of course would use undampt waves, would be connected to the aerial designed by General Ferrié, and which has been previously described.

STATION RADIOTELEGRAPHIQUE
LA FAYETTE
EN L'HONNEUR DU GENERAL
LA FAYETTE
CONÇUE DANS LE BUT D'ASSURER A TRAVERS L'ATLANTIQUE DES COMMUNICATIONS SURES ET ININTERROMPUES ENTRE LES FORCES EXPEDITIONNAIRES AMERICAINES ENGAGEES DANS LA GRANDE GUERRE ET LE GOUVERNEMENT DES ETATS-UNIS D'AMERIQUE
ERIGEE PAR LA MARINE DES ETATS-UNIS AVEC LE CONCOURS ET A L'INTENTION DU GOUVERNEMENT FRANÇAIS
LA FAYETTE
RADIO STATION
IN HONOR OF GENERAL
LAFAYETTE
CONCEIVED FOR THE PURPOSE OF INSURING ADEQUATE AND UNINTERRUPTED TRANSATLANTIC COMMUNICATION FACILITIES BETWEEN THE AMERICAN EXPEDITIONARY FORCES ENGAGED IN THE WORLD WAR AND THE GOVERNMENT OF THE UNITED STATES OF AMERICA
ERECTED BY THE UNITED STATES NAVY IN CONJUNCTION WITH AND FOR THE GOVERNMENT OF FRANCE

Photograph of the Memorial Tablet Placed Above the Door of the Lafayette Station.

As generators of undampt waves, only the arcs were known at that time. All the French factories were being used for the fabrication of ammunition; the U. S. only was able to quickly furnish the arcs and towers. The part of each nation was then determined. The American Technic furnisht and erected eight 835-foot towers of the same type as those used at Arlington Station. It furnisht and built two ultra-powerful arcs of the Federal Co., fed by a 1,000-kilowatt motor generator, and delivering 5,000 amperes into the aerial, which had a resistance of 1.6 ohm. The French Engineers designed the aerial, the ground and the buildings and then constructed them; they also had to make the concrete foundation for the towers. This was not an easy job, owing to the soft ground in which they had to be built. More than that, during the construction, it was decided that in the same building, a high frequency Bethenod-Latour alternator of the same power as the arcs would be installed. These decisions being made, the construction started.

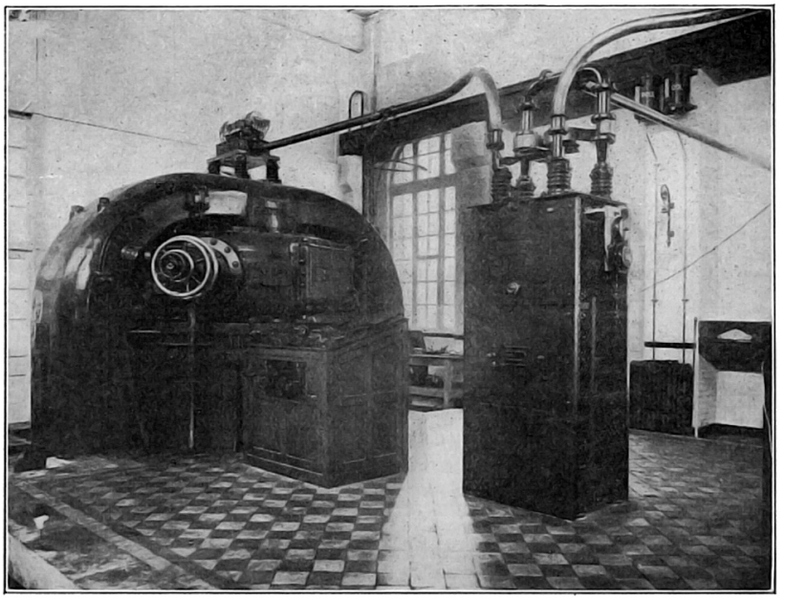
During the first six months of 1918, the preparatory work was completed. The work began effectively during the summer of 1918. At the end of October, four of the eight towers were built up to 200 feet. Almost all of the American material had reached France, and it was hoped that transmission could take place as soon as March, 1919, using only four of the eight towers to support a smaller aerial. When the armistice was signed, work stopt, for the station lost its military significance. It was necessary to find a new use for it, and

it was only in February, 1919, after long discussions, that it was decided the Lafayette station would be used for commercial traffic.

The agreement signed by both governments stated that the radio station should be constructed according to the previous plans. The U. S. agreed to sell to the French government all the furnisht material at cost price.

The work started again with greater activity and the eight towers were completed in November, 1919. The arcs and all of the electrical installation were in working order for a local test in January, 1920. During the spring of the same year, the antenna made in three parts was erected. It will be described later.

At last in August, the first transmission with full power was made, very successfully. All the work was conducted with remarkable activity and very competently by an American force of men who have very good standing with the French authorities.



Photograph of One of the Arcs Built by the Federal Co., Delivering 500 K.W. in the Aerial. These Arcs are Supplied With 1,250 Volts D.C. by a 1,000-K.W. Motor Generator and are the Largest Ever Built.

The French post-office to whom the station has been given, has installed a device, allowing the transmission of the messages from Bordeaux; a receiving set with a static barrage device built by the French Signal Corps was also erected in the station. The station was opened on December 18th, which was a notable Franco-American event, showing the unbreakable friendship between the two great republics.

How is this station now, and what results are to be expected from it? Also where is Croix D'Hins? It is a station on the railway line Bordeaux-Bayonne. Sixteen miles southwest of Bordeaux, the earth is very wet and this seems to promise a good ground. In this vast field are erected the eight towers built by the Pittsburgh & Des Moines Steel Co., which can be seen at a great distance.

In front of the towers, which cover a surface of 1,350 by 4,000 feet, is built the station itself, in which are the inductance, the two powerful arcs of the Federal Telegraph Co., and all the electrical machinery necessary to supply the power. In some other little buildings are the work-shop, the stock-room and the quarter for the operators.

Near the entrance is a transformer station receiving the current of 50,000 volts from Bordeaux. Two stepdown transformers of 2,500 kilowatts each, lower this tension to 2,200 volts, which supply the current to the various motors used for operating the arcs, another transformation lowers this current to 220 volts for the lighting, the motors of the work-shop and other purposes.

If we enter the great building and follow the circuit from the first transformer station up to the aerial, we find a series of

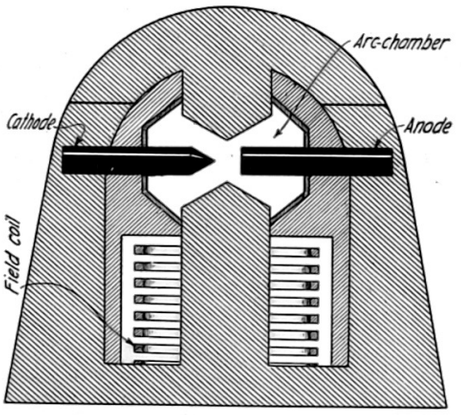


Diagram of the Arc Having a Closed Core and Only One Field Coil.

apparata and machinery that we will now describe.

The largest machines are the generators furnishing the high tension current for the arc. These are 1,000-kilowatt dynamos delivering D. C. at 1,250 volts. They are run by synchronous motors which are fed with three phase 2,200 volts current. To these machines which are four in number (two in service and two at rest) are added some 30-kilowatt motor generators which furnish 65 volts D. C. for the magnetic field in the arcs, and also some 20-kilowatt motor generators, delivering 575 volts used in the manipulating device; and last, some 5-kilowatt motor generators, delivering 115 volts D. C. for the field of the 20- and 30-kilowatt dynamos. The motors running these dynamos are designed to run with 220 volts, all the other motors running with 2,200 volts.

The 1,000-kilowatt motor generators feed the two arcs which are of the same type and which are the most powerful ever built, delivering 500 kilowatts into the antenna. Figure 5 is a photograph of these arcs, in which only one coil is used to produce the magnetic field. One electrode is made of copper with a water-cooling device, the other one is of carbon; the latter turns slowly. The compartment in which the arc burns is filled with alcoholic vapors, and is cooled by a water circulation.

After the arcs, we see the inductance which is erected in a special room, whose walls are covered with wires forming a Faraday cage. This inductance is made of heavy stranded cable, each wire being insulated from the others. This cable is wound on 12 insulators built on a concrete base; five taps are taken which can be connected at will to the antenna, allowing an easy change of the wave-length.

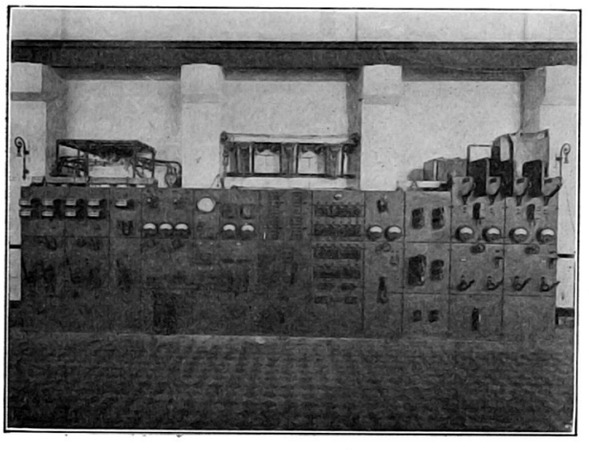
The total resistance of this inductance is ¼ of an ohm. At the bottom is the manipulating device, composed of 78 relays, which cut and connect a few turns of a cable not connected to the inductance itself. The opening of this separate circuit causes a detuning of the aerial circuit, and this allows the station to work with a counter wave.

Those 78 relays are controlled in turn by 28 other relays, themselves operated from Bordeaux by another relay, which is actioned by a Kleinschmidt transmitter using a perforated strip of paper for a fast automatic transmission. *This device allows the operation of the Lafayette station from Paris.*

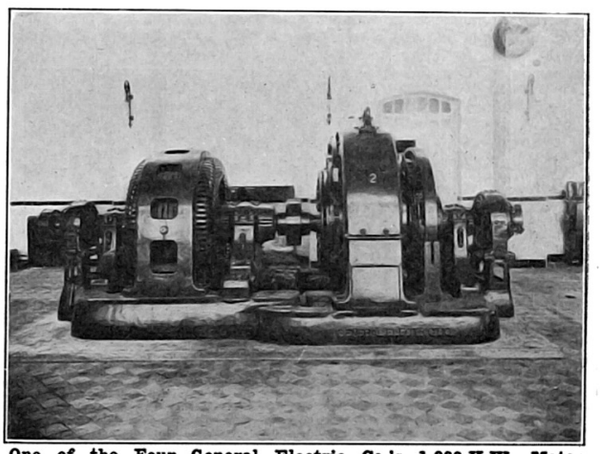
The aerial is made of 16 wires with a 10-wire lead-in. It is supported by the eight towers which are 1,350 feet apart in each direction. The towers are fixt 2 x 2 by guys supporting a traction of six tons, and which are insulated from the tower by heavy porcelain insulators, furnisht by the U. S. These insulators are 5 feet long and weigh about 400 pounds each. The capacity of such an aerial is about .05 microfarad, its natural wave-length being 8,000 meters.

At the beginning of the construction, the shape of the aerial was discusst at length by French and American engineers.

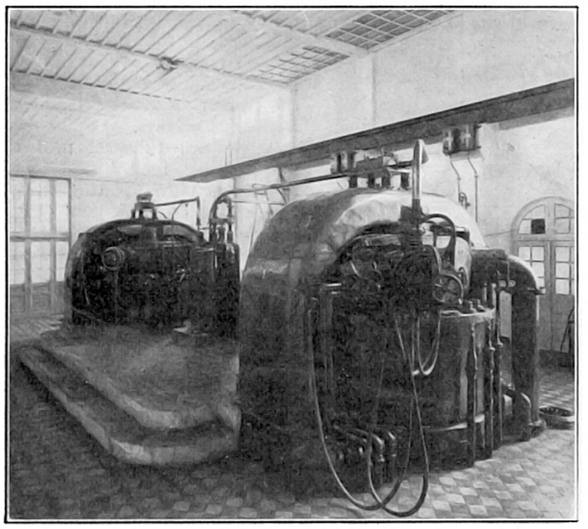
The latter wanted to use an umbrella



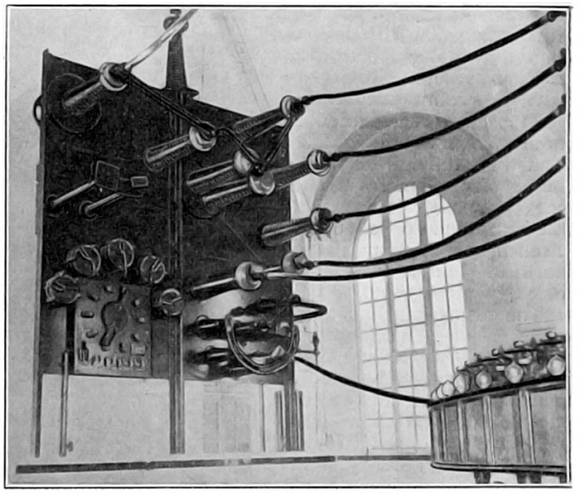
View of the General Switchboard of the Station, With All the Control Apparatus.



One of the Four General Electric Co.'s 1,000-K.W. Motor Generators Supplying the Current for the Arcs. On the Right is the D.C. Dynamo and on the Left the A.C. Motor.



These Two Arcs Used at the Lafayette Station Permit a Continuous Service. Note the Numerous Pipes Used for Cooling the Various Parts.



This is the Switchboard for Changing the Wave-Length. The Cables From This Board are Connected to the Big Inductance Shown on the Front Cover of This Magazine.

aerial, using only seven towers, but the inverted L aerial that the French wished to build had already given excellent results, and so was erected in the direction of Washington. The ground is made of 300 sq. ft. of copper plates buried under the arcs. From this plate are soldered in a star shape, 40 copper strips, four inches wide and 200 feet long. A circle made of copper wire is connected to the end of these strips. Then 12 No. 12 B. S. wires are connected to this circumference and are soldered 6 by 6 to copper pipes three inches in diameter and 60 feet long, buried in the ground vertically; all the ground connection is buried about two feet deep. This ground has been connected also to the towers and this lowered the resistance of the aerial circuit about 30 per cent. The resistance of the circuit being about 1 ohm 5, it is possible to put 600 amperes into the aerial.

The results obtained by the Lafayette station are fully satisfactory. Its signals are heard at the most favorable hours *by all the receiving stations in the world.* It is heard 24 hours a day by the American stations. Permanent communication is thus insured with the United States. To the receiving stations of the whole world it will be possible to send messages, during several hours each day and the greater part of the night. This has been proved by the experiment carried out by the American Navy, during the months of August and September.

It can truthfully be said that this station spreading waves over the world compares in grandeur with the Statue of Liberty on the other side of the Atlantic. Like the Goddess, it will be a perpetual reminder to other nations of the friendship between France and the United States and how they fought shoulder to shoulder during the war, and how their collaboration produced this masterpiece of the peace—the Lafayette Radio Station, the most powerful in the world.

A Detector and Three-Stage Amplifier for Fifty Dollars

An Instrument Assembled from Standard Parts

By E. A. WHITE and F. L. HOPKINS

THE accompanying photographs, Figs. 1 and 2, show respectively the front and rear views of a neat and efficient detector and three-stage audio frequency amplifier made of the best materials at a total cost of only fifty dollars. The interesting feature of this instrument is that all the parts, including the cabinet, were bot at retail in a finisht condition and then assembled so that with the itemized list which follows, anyone can duplicate it.

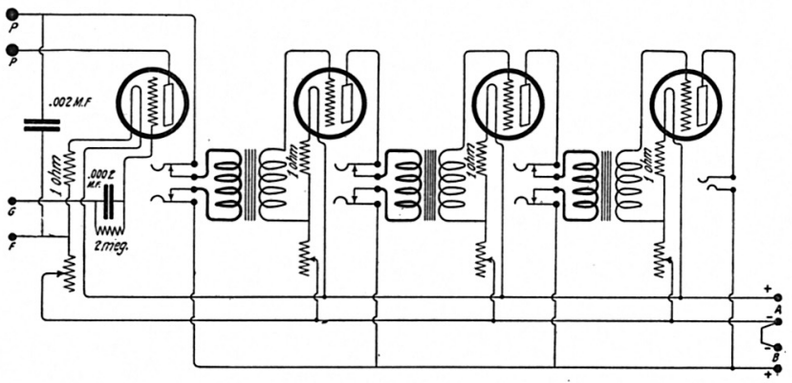


Diagram of the Detector and Three-Stage Amplifier. Note the 1-Ohm Resistances in the Filament Circuits to Provide the Proper Negative Potential to the Grids and the Shunting .002 Mfd. Condenser for the Use of a Regenerative Circuit.

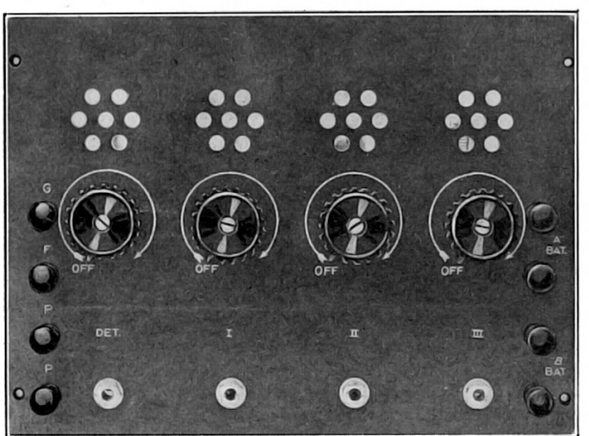
MATERIAL REQUIRED AND ACTUAL PRICE PAID FOR THESE PARTS.

1 Formica panel 9" x 12" x ¼"	$2.00
1 Natural finish oak cabinet 9" x 12" x 4"	6.00
8 Federal Tel. Co. amplifier transformers	21.30
4 Federal Tel. No. 36012 jacks at 85c	3.40
4 Paragon rheostats for back mounting	7.00
4 Murdock sockets at $1	4.00
8 Tresco binding posts at 12c	.96
Miscellaneous	5.34
1 Fixt bridging condenser, .002 mfd.	
1 Fixt grid condenser, .0002 mfd.	
1 Grid leak, 2 megohms.	
1 Formica strip, 3½" x10"x⅛" for shelf.	
2 Small brass brackets of strip brass.	
16 Small brass machine screws.	
16 Small brass machine bolts.	
4 Woodscrews, half-round, nickel-plated.	
Connecting wire, a few feet of No. 10 bare copper.	
Engraving panel as described.	
Total	$50.00

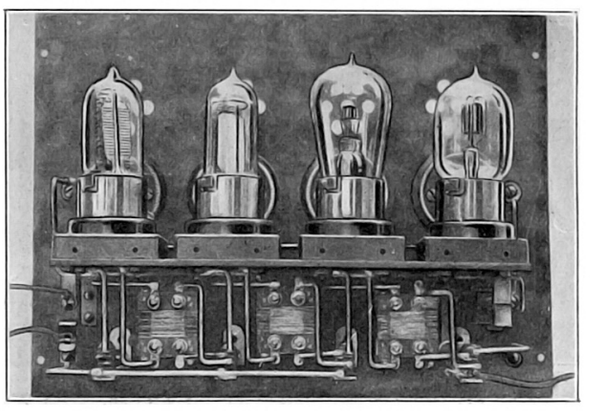
The only tools necessary for assembling are drills, taps, screwdrivers, pliers, and soldering iron; and the whole work of assembling can be done in a couple of evenings, as all the parts are ready to put together as soon as the panel has been drilled.

The 9" x 12" x ¼" Formica panel is given a dull grain finish by sandpapering carefully with No. 0 sandpaper and by then rubbing with oil. As all the mounting is done from the back of the panel, and as none of the holes are drilled thru except for parts that appear in front, no supporting screw heads appear on the front of the panel. This makes a much more

(*Continued on page 564*)

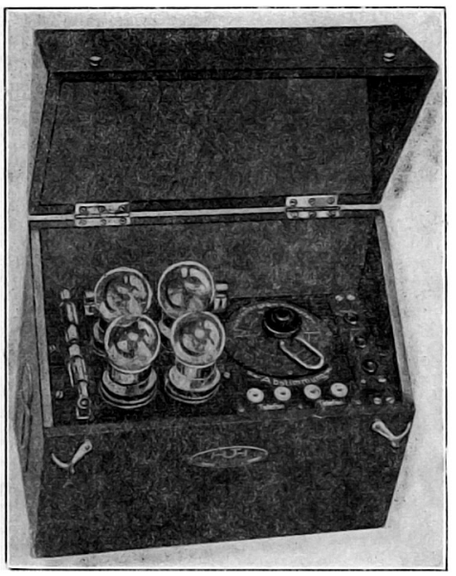


Front View of the Well Planned Amplifier Designed by Mr. E. A. White and Mr. F. L. Hopkins.



Back View of the Panel Supporting All the Parts. Note the Compactness and Neatness of the Work.

New German Radio Sets



A Very Compact Receiver and Three-Step Amplifier Especially Designed to Receive Time Signals on a Small Indoor Loop Aerial.

SINCE the war, German Radio engineers have developed new instruments, especially C. W. transmitters, a few of which are shown in the accompanying photographs.

Fig. 1 shows a 2-kilowatt set, consisting of three sending units, each of which, according to the requirements and the room available, can be arranged in any desired relation to each other. On the left, the first case contains the high tension transformer, the rectifier along with the regulation organs for regulating the heating current, and the grid circuit. The latter has a solid Glimmer condenser and a self-induction variometer, which can be tuned up to given wave-lengths by means of a knob on the outside, and a scale directly calibrated for wave-lengths. The scale of the grid circuit has two divisions, the smaller going from 300 to 600 meters and the larger from 600 to 1,500 meters.

The middle case contains four power tubes in its upper part, all connected in parallel. The heating of the four tubes and of the rectifier is done by A. C., so that only a single source of power such as a 500- or 600-cycle machine of about 2½ k.w. is necessary. In the lower part of the middle case there is a block condenser, such as previously described; also the heating transformer, which by three independent secondary windings gives the heating current for the rectifier and power tubes; the regulating apparatus; the hot wire ammeter, used for the control of the heating cuurrent, and finally the so called compensation transformer.

This transformer is so designed that the filament current is kept constant in spite of the changes of load which happen when the key is presst.

The third cabinet contains, finally, the antenna coil constructed as a variometer, a transformer for the shorter wave-lengths, as well as the coupling and wave connections.

Fig. 2 represents a complete 1-k.w. set. The transmitter is of the same type already described but is contained in only one cabinet. On the right of the photograph is the receiver and fixt on the wall is the control panel. Under the table is the 1,000-watt motor generator supplying power to the transmitter.

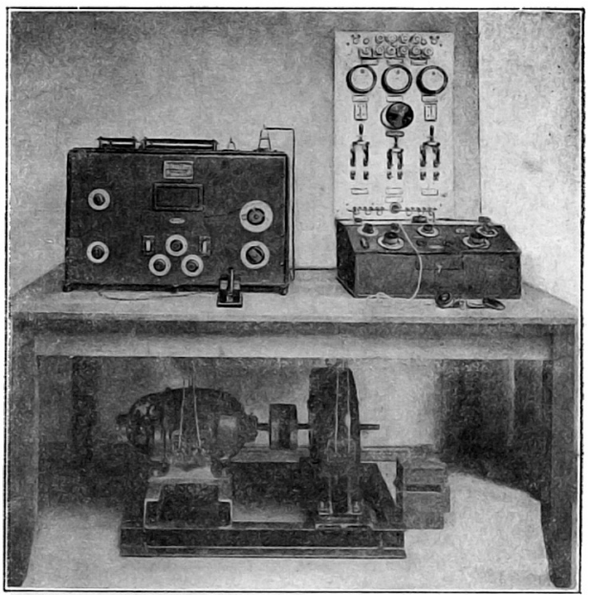


Fig. 2. A Complete 1 K.W. Undampt Wave Set. On the Right is the Receiver and Under the Table the H.T. D.C. Generator.

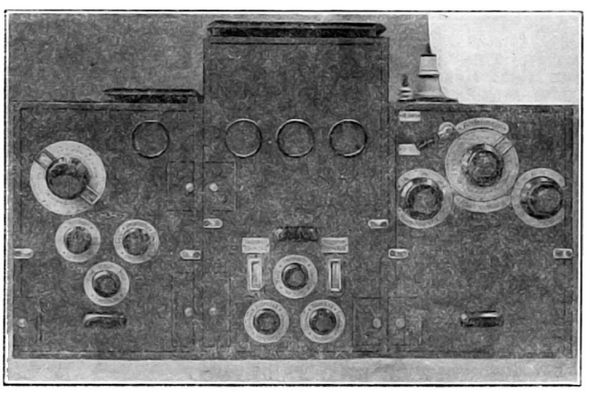


Fig. 1. Here is a 2-K.W. C.W. Transmitter Equipt With Four 500-Watt Tubes. The Three Cabinets From Left to Right Contain the Rectifier, the Power Tubes and the Wave-Length Control.

The photograph, Fig. 3, shows a very sensitive receiver of unique design and absolutely foolproof. It is designed especially for reception, by amateurs, of time signals on a loop aerial four feet square. The receiver, which is tuned by merely adjusting the variable condenser, is hooked up with a V. T. detector and 3-stage amplifier, making possible the reception of signals at a great distance from the big stations sending the time signals, press and weather reports.

The amplifier requires no adjustment at all: a small switch is simply turned on to light the filaments which are connected in series with small fixt resistances of the correct value, insuring the maximum sensibility.

Everything is contained in the receiver set except the loop aerial and batteries.—*Photos courtesy of Dr. Erich F. Huth.*

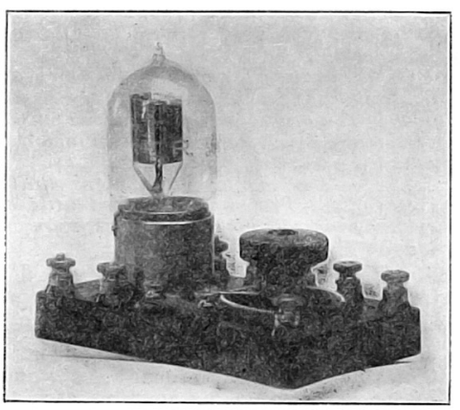
A Unique Vacuum Tube Control Panel

THE family of the vacuum tube control panels has annexed a new member, which in fact is very good looking and fitted with the latest improvements. A photograph of this new instrument appears on this page and, as can be seen, it may be fixt on any type of receiver or used separately.

The connections are such that the tube may be used as a detector with any tuner, or as an oscillator. Used in conjunction with an amplifying transformer, this panel allows an accurate control of the amplifying tube.

On this panel unit, the base of which is made of moulded black "condensite," are fixt a mica grid condenser of the proper value, an adjustable grid leak, a rheostat, a standard socket and 9 binding posts. The connections made in the base are shown in the diagram, Fig. 2.

The rheostat is particularly well made, and wound on an insulating core. The special wire is wound in such a way that it cannot be short circuited neither will the turns loosen when used. The resistance of the unit is 6 ohms and its current carrying capacity 1½ amperes.



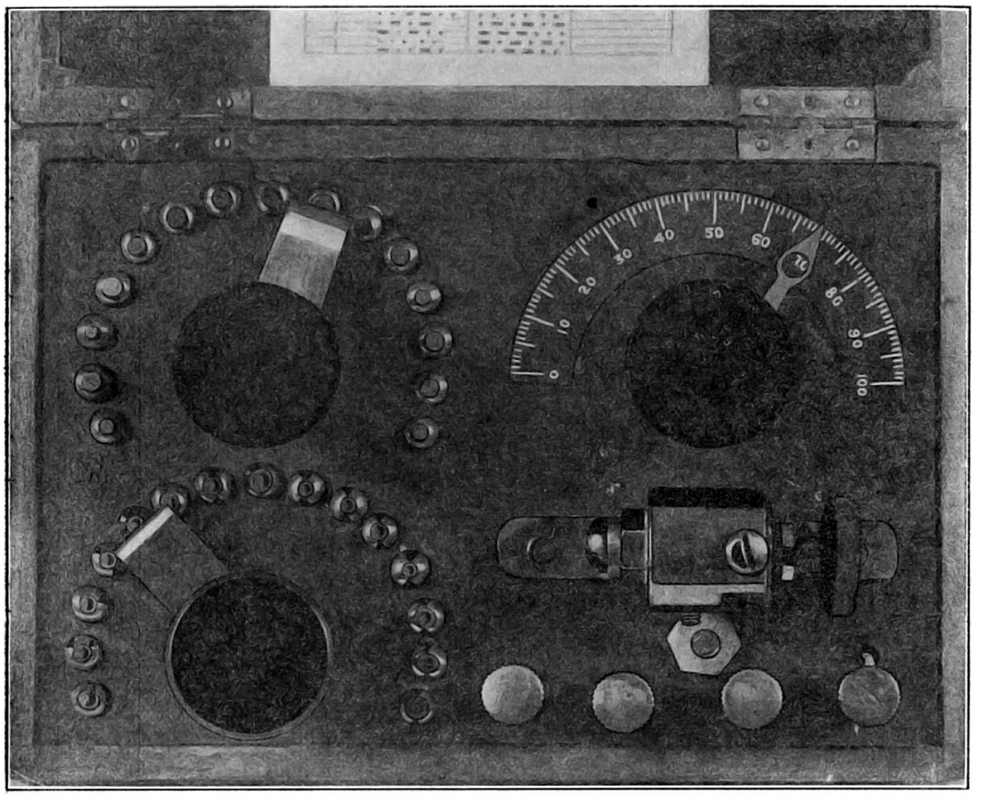
A Very Efficient Instrument of a New Design, More Compact Than the Other Type of V.T. Control Panel. It is Made of Insulating Material and Moulded in One Piece.

The grid leak of the pencil mark type can be easily varied by the operator to suit the characteristics of the tube used, it being necessary to provide sufficient low resistance to enable excessive grid charges to leak off and thereby prevent paralyzation of the tube. The grid leak should be adjusted by drawing lines across between the two binding posts with a soft lead pencil or India ink until the proper resistance value is obtained. A tickler coil may be connected for regeneration or reception of undampt waves at will.

The amateurs will certainly be interested in this new apparatus which can be incorporated in any circuit and which measures only 5" x 3⅛". All metallic parts are heavily nickel plated and this unit will be found very useful, especially in the portable sets, owing to its compactness.—*Photo courtesy Adams Morgan Co.*

Awards of $100 Portable Radio Prize Contest

THIRD PRIZE WINNER



Full Size View of Mr. Toran's Portable Receiver. This Little Set is Fitted With a Small Variable Condenser Which May Be Seen in the Upper Right Hand Corner and a Steady Contact Detector, Which is Particularly Useful in this Kind of Receiving Set.

Editor's Note:

We are pleased to present this month the portable set, which has been awarded the third prize in our portable receiver contest.

This set, which was built by Mr. Robert I. Toran, of Cambridge, Mass., is really an efficient instrument. It was tested in the laboratory of Radio News *and found to be very good, a great number of amateur stations being heard as well as several ships at sea.*

The new feature in this receiver is the steady contact crystal detector, which is not as extensively used as it should be by the amateurs. The crystal used has a flat face on which is presst a thin mica washer; the contacts on the crystal are made in several points by a rack like piece, which is shown in the diagram, Fig. 2, and which may be firmly applied on the crystal by means of a screw. When fixt, the sharp points of the rack just drill a small hole thru the mica washer, thus making steady contacts on the galena. This type of detector, when adjusted cannot get out of order and it is very convenient, especially in a portable set.

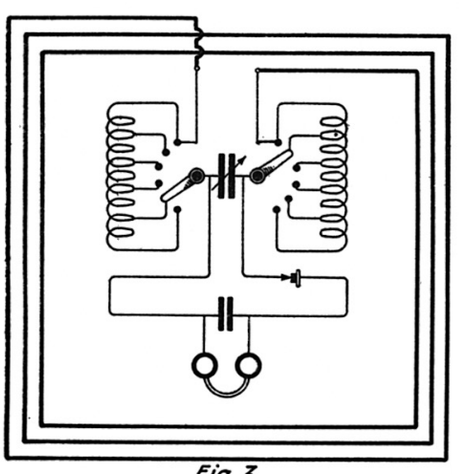


Fig. 3

Connections of the Set When Used With a Loop Aerial.

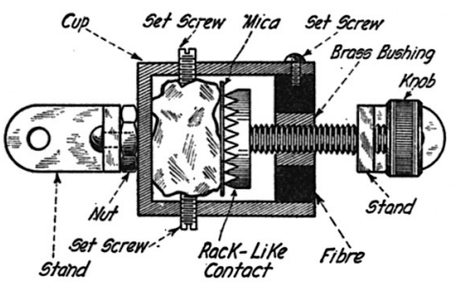


Fig. 2

Inside View of the Steady Contact Crystal Detector Used in the Portable Set. Note the System of Contact on the Crystal.

On a two-wire L aerial, 60 feet long and 60 feet high, the reception is very strong. The hook-up used by Mr. Toran is an exceptionally good static eliminator and permits quite a sharp tuning.

We extend our congratulations to the constructor of this well planned little receiver, a description of which is given below by Mr. Toran himself.

A PORTABLE RECEIVING SET.
By Robert I. Toran.

This portable set is entirely home-made and consists of a spool 2¼" in diameter by 1¼", wound with a primary of 250 turns of No. 26 wire, taking 10 turns each for the first five points, 15 turns each for the next five points and 20 turns for the last five points. The secondary is wound the same way.

A variable condenser, also home-made, consisting of 17 plates 2" in diameter, is shunted across the primary, and a fixt condenser, made of three strips of tinfoil 10" long and 1" wide and sealed in wax, is connected across the fones.

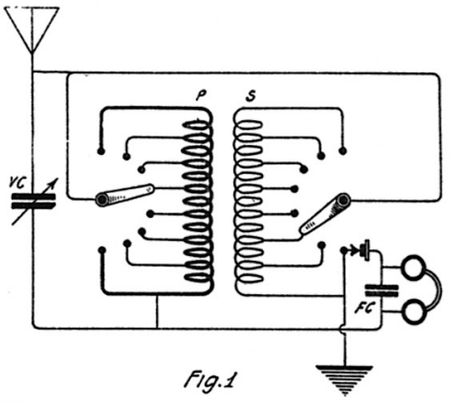


Fig. 1

Diagram of Connections in the Receiver Designed by Mr. Toran. This Hook-up is a Very Good Static Eliminator.

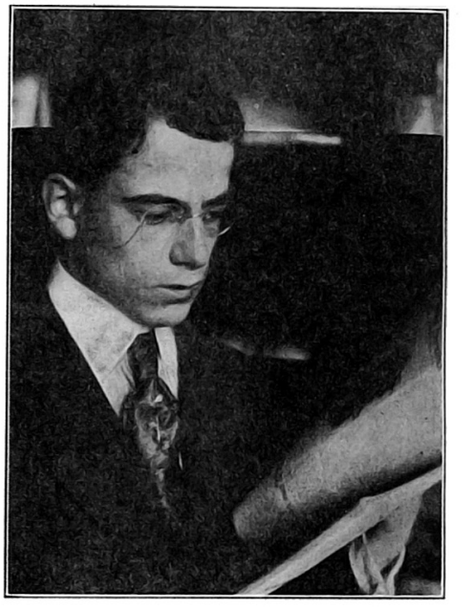
The permanent detector, which is of my own design, is shown in Fig. 2.

Several points of contact are obtained on the crystal by means of a special piece fitted with conical protuberances, applied on the flat face of a good crystal of galena, thru a piece of thin mica. When compresst the sharp tips of the cones pass thru the mica, making contacts of very small surface as a cat whisker would, but with the great advantage that it doesn't get out of order. The pressure is adjusted by means of a screw. The hook-up of this is somewhat novel and I have not seen it duplicated as yet. It was discovered by me while making experiments with different hook-ups.

The tuning of this set is extremely fine and the variable condenser, shunted across the primary as shown in the diagram in Fig. 1, eliminates any undesirable messages coming in, while listening for a particular station.

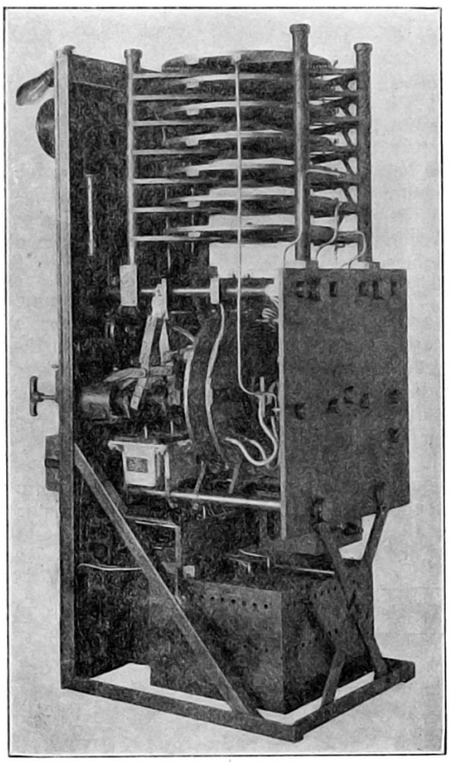
The aerial consists of 20 feet of six fine threads of wire and is enclosed in the core of the spool when not in use.

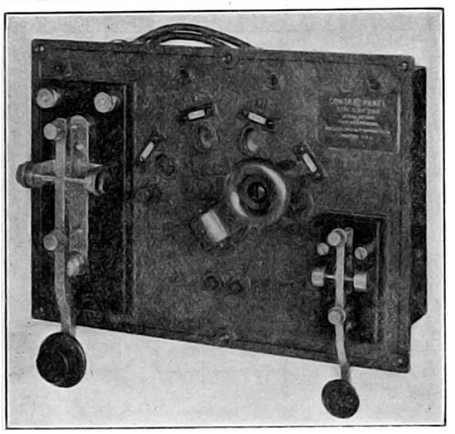
(*Continued on page* 570)



Photograph of Mr. Robert I. Toran, Who Designed and Built the Little Portable Receiver Which Was Awarded the Third Prize.

A New 2-K.W. Panel Transmitter





The Upper Photograph is a Rear View of the Transmitter, While the Lower One Shows the Control Panel From Which All Operations in the Set are Effected.

The photographs reproduced here depict a new type transmitter, which represents a decided advance in radio transmitter design. The development of this transmitter has just recently been completed. The striking feature of the equipment is the Priess-Barth magnetic wave changer which permits remote control of the transmitter, and allows the operator to shift instantaneously to any one of four different wave-lengths.

The transmitter can be adjusted for any four wave-lengths up to 2,000 meters. Complete control is obtained by a small desk panel shown in photograph. This panel controls wave changing mechanism, starts and stops the motor generator, or permits continuous running of the machine as the operator desires, operates the magnetic antenna transfer switch, and is equipt with small and large keys for current thru a relay key or direct. This transmitter requires no more space than present designs now in use, and in several instances requires considerably less.

The time required to shift from one wave-length to another is approximately one-quarter of a second, so for all practical purposes this shift is instantaneous. It is believed that the use of this transmitter in commercial work will greatly speed up the handling of traffic.

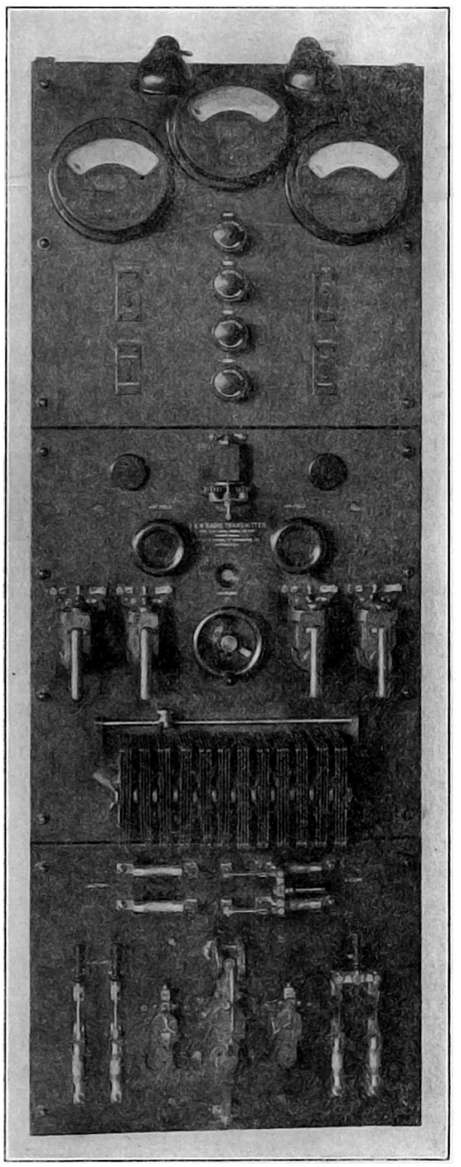
This remote control system has been carefully studied and it has proved absolutely constant in operation avoiding all troubles for the operators who have to give very little attention to keep this transmitter in good working order.

The quenched spark gap, which is built in sections, has a large cooling surface and does not heat even when constant heavy traffic is handled. It does not require frequent cleaning as is the case with most of the quenched gaps actually in use

The complete transmitter is built on the panel, making a compact unit, and only the small wave-length, manipulating control panel, and the motor generator are located elsewhere, in the operating room or in the most convenient place.

The wave-length may be changed by hand, simply by pulling one of the four handles in the middle of the panel, making the necessary connections on both the O.T. and the aerial inductances which are of the pancake type.

Photos courtesy Wireless Specialty Co.

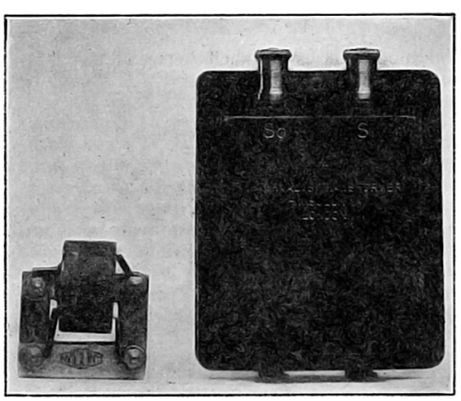


Front View of the New 2-K.W. Set. Note the New Quenched Gap Built in Sections and the General Arrangement of the Panel.

New Amplifying Transformers

Two new models of amplifying transformers of which photographs appear on this page, have recently been developed by two well known firms, who have already specialized in the construction of very efficient receiving apparatus and amplifiers. These transformers, if they are not yet, will soon be placed on the market. As can be seen, there is a great difference in size between the two models, one of which is English make, while the other is manufactured by an American concern.

The small one which is only 2″ x 2″ weighs about three ounces and is especially useful in portable sets since it saves space and weight. The big one is about 4½″ square and weighs about four pounds; it is enclosed in a cast iron case and fitted with heavy binding posts. It is absolutely weatherproof and the metallic case may be connected to a point of the circuit to avoid capacity effect which may occur when the transformer is used in regenerative circuits.



In Spite of the Difference in Size These Two Transformers Give the Same Results.

In order to know what results could be obtained with both of these, they were tested in the laboratory of RADIO NEWS with various tubes, including Western Electric's.

Altho it seems that the results should be better with the larger type, it has been found that the ratio of amplification is the same in both, the smaller transformer, however, giving a clearer note.

This interesting experiment shows that it is not necessary to use such large sizes of transformers in an amplifier since the little American model gives the same results. In designing this newest model the American radio engineers were successful in getting rid of cumbersome and heavy instruments still in general use in Europe.

Photo Courtesy Pacent Co.

A True Undampt Wave Receptor

By ERNEST C. MIGNON

A Compact Receiving Set for the Reception of Undampt Waves Only Embodying Electro-Magnetic Field Control.

THE accompanying photograph illustrates the compactness of this receptor, the size of the cabinet being 12" x 9" x 6½". The instrument receives undampt wave signals only. No loose couplers, vario-meters, loading coils, etc., are used in this cabinet.

Figure No. 1 gives the general layout and schematic diagram of the set, showing the undampt tuner consisting of three ring type coils of equal capacity, wound with No. 32 D.S.C. magnet wire. These coils are placed edgewise to each other, the "clover leaf" way, as a true undampt wave receptor requires only a remarkably small coupling inductance, but considerable self inductance.

These inductances are adjustable to the finest degree by the use of a magnetic field control, attached to one of the two closed circuit coils. This control consists of a metallic ring of variable circumference or surface and controls the electro-magnetic field of the undampt tuner.

This control or variable short circuiting device, simple as it may seem, is one of the most important improvements in undampt wave reception, as it enables the operator to tune out interference by signals of almost the same wavelength as the one he desires to read. All three coils are physically or metallically inter-connected.

It may be well to state that this receptor has absolutely nothing in common with the ordinary type in general use, which consists of Primary, Secondary and so-called tickler circuits. These tickler circuits are not required in this receptor as it is an instantaneous and permanent oscillator. It can be depended upon to bring in every signal emitted by any undampt transmitters, clearly and distinctly, including transatlantic signals of any wave length now in use. Dampt wave interference is impossible. Static and other noises are considerably eliminated.

The condenser is of the variable duplex type preferably of a ferrous metal.

It is the opinion of the inventor that it will be impossible to build an undampt wave receptor that will receive dampt wave signals as well as one of the standard dampt wave receptors, since they function on two distinctive principles.

In general practice it is customary to tune in arc signals on the common dampt wave receptor by simply adding large enough inductances and by changing one of the tuner leads in the plate and phone circuit, causing an oscillating circuit of a freakish and unreliable nature. Such an arrangement permits both dampt and undampt signals to come in together with strong electrostatic interferences especially during the summer months, rendering the reception of clear and distinct signals a difficult task.

* *Photo by courtesy of Mignon Mfg. Corp.*

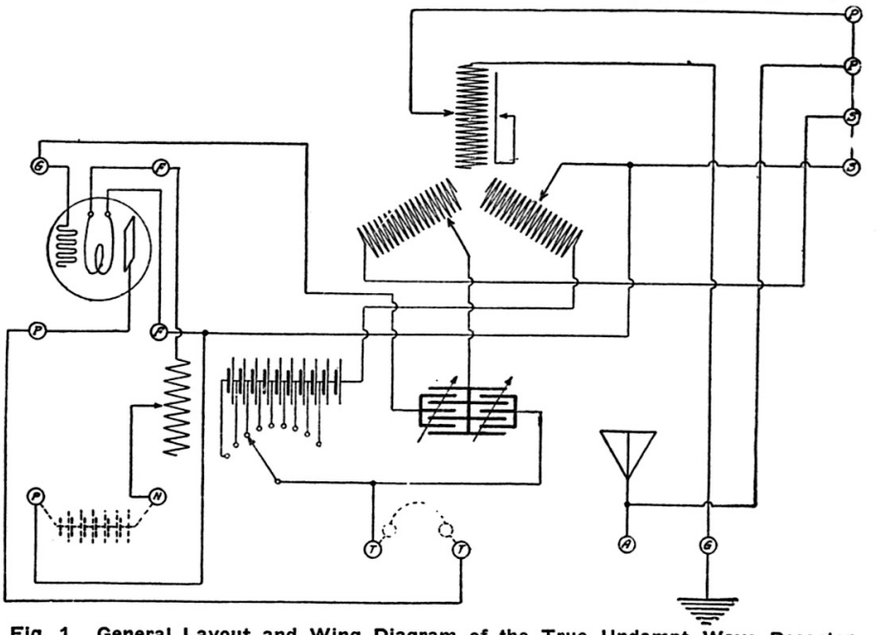


Fig. 1. General Layout and Wing Diagram of the True Undampt Wave Receptor Described by Mr. Mignon.

"A Word to the Wise Is Sufficient"

The U. S. Government receives many complaints from different sources, especially from foreign governments, regarding the great amount of interference caused by American ships and stations not complying with the rules for the method of calling as shown in the proceedings of the Radio Telegraph Convention, London, 1912.

The majority of operators very seldom confine their calls and signs to three (3), as called for in Article XXV of the proceedings, as nearly everyone signs off with "AR" or "K," which is uncalled for. By careful reading of Article XXV you will see that no *sign-off* is necessary other than the call letters of your own station made three times. The station called, in answering, calls the same way, but uses the letter "K" to signify they have heard and are ready to receive. When actual communication has been established between two stations the signals "AR" and "K" can be used as set forth in Article XXXI.

Editor's Note to Commercial Operators: Boys, our heart is with you. We congratulate you on the excellent progress you have made in recent years towards the betterment of your living and remunerating conditions. We believe it is due you who sail the seven seas and who are helping make the U. S. Merchant Marine a success. We want to see you advance in every way. But, above all, take your profession seriously and operate like professionals. Learn well and strictly follow the "Rules of the Road." Take unto yourselves the serious purpose and intent of those two excellent guides, "Commercial Traffic Regulations" and "Radio Communication Laws of the U. S." Digest them well. Most operating companies furnish them to each ship station as part of the equipment. If you have not a copy of either book Uncle Sam will mail you "Radio Communication Laws of the U. S." by writing to the Government Printing Office, Washington, D. C. The price is fifteen cents per copy. Better yet, your local radio inspector will furnish you with the book.

DIRECTIONAL FORECASTING OF WEATHER BY RADIO.

Radio is now used by the official weather prophet in England. By means of directional equipment at two listening-in stations the exact position and track of a thunderstorm can be quickly calculated.

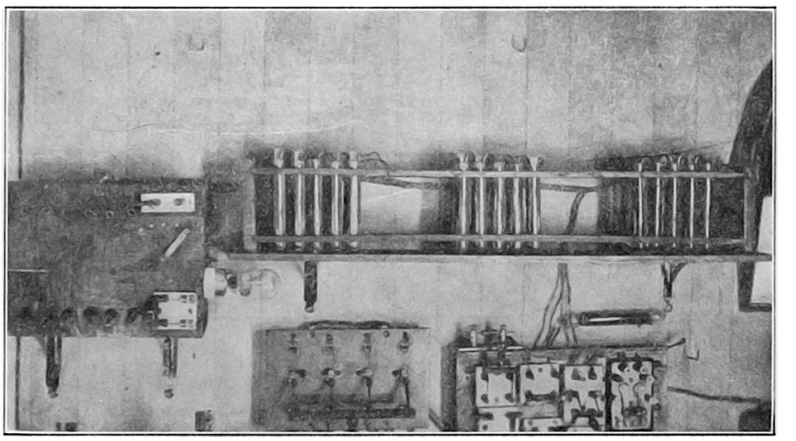
Warnings are sent out to farmers and others directly interested in the weather at six cents per message.

A New Type of "B" Battery

By HARRY BOYCE, Jr.

IN the operation of an Audion receiving set, the "B" Battery is one of the most important points and in this article I am going to describe one I made several months ago, and which is the most successful I have ever used. The cost of building is not excessive, and the maintenance cost after it has been constructed is practically nothing.

The one feature of this battery, which marks it as being different from others of the same type using the same solution and test tube design, is the incorporation of plugs and jacks, by means of which the battery may be charged at a relatively low rate, yet discharged at sixty volts or more, according to the number of test tubes used.



Photograph of the switchboard and storage "B" Battery built by Mr. Harry Boyce, Jr. This may easily be duplicated by the amateur to supply the H.T. to the V.T.'s of either the transmitter or receiver. It is a very economical way to obtain D.C. and get rid of the dry batteries.

CONSTRUCTION

The battery itself is composed of 30 test tubes whose dimensions are 1" by 6"; this number is sufficient for a sixty volt battery. After a rack has been made, these tubes should be grouped in sets of five, making six groups. If the voltage is to be increased, more tubes should be added, but always in sets of five, each set giving an increase of ten volts. Also a corresponding number of plugs and jacks must be added to take care of the additional cells.

Any amateur can construct a suitable rack for the tubes, but I am including dimensions of the one I used for the sake of those who lack the time to figure out the details. This rack was primarily designed to hold fifty tubes, but by leaving the 20 holes vacant, the tubes are nicely spaced, and necessary room is also provided in case an addition should be made. However, if the builder wishes to provide space for only 30 tubes, 15 on each side, he should alter these dimensions accordingly.

For the base use a board ½" x 6" x 3'. About 1" from each end secure two uprights ⅝" x 4" x 6". Each of these two uprights should have two grooves about ⅜" wide and ⅜" deep, cut in about ½" from each end. For the supporting crosspieces use two boards each ⅜" x 4" x 32⅝". Divide both lengthwise with a pencil line into two equal parts, and on each side of this line bore twenty-five holes 1" in diameter. Place these two boards in the grooves of the end pieces and then fasten the latter to the base. After completion the rack should be painted, any good stain will do, and when dry given a thoro coat of hot paraffine to insure perfect insulation and to prevent leakage.

Now procure 50 lead strips $\frac{1}{16}$" x $\frac{11}{16}$" x 13". These strips may be wider and thicker than the dimensions, but should not be narrower or shorter. Brighten both sides and edges of each strip with emery paper. This is a rather tedious job, but may be facilitated by attaching the emery to a rotary gap motor. Then with a sharp knife cut slits crosswise in the surface of the lead. Run these lines both directions and on both sides of each strip, so that the acid may have the best possible surface to act upon.

Cut six of the strips in halves, for the end plates of the six sections, and drill a small hole in one end of each to be used for connection. Bend the remaining strips in the shape of a U and insert one leg in each tube, thus eliminating connection between cells. As stated before, after completion of this part the 30 tubes should be divided into six sections with five tubes in each section, the purpose of which will become apparent in another paragraph.

For the solution to be used in the tubes, dilute pure sulphuric acid with water until its specific gravity becomes 1.210. Always pour the acid into the water. The gravity should be tested with a hydrometer. Fill each tube within ½" of the top, and pour a thin film of oil on top of the acid to prevent evaporation. I experienced a slight difficulty in keeping some of the plates apart, especially the end plates, and to overcome this I placed pieces of glass $\frac{1}{16}$" x ⅜" x 5" between them.

The next part to be constructed is the charging unit. This battery is intended to charge in multiple and discharge in series, thus allowing it to be charged with a much lower rate than usual, with consequent better service. To accomplish this, a system of plugs and jacks is used. Procure six two-contact plugs and jacks, four of the latter having a third point by means of which they are short-circuited when the plugs are removed. If this type of jack cannot be procured, bend the two contacts so that they are shorted whenever the plug is removed. As indicated in the accompanying diagram, when all the plugs are out, jacks 1 and 6 are open and the other four short-circuited, which places the entire battery in series, the manner in which it discharges. These jacks should be mounted in a box of some kind, large enough to hold the plugs and the slack cord attached to them when they are not in use. Holes should be bored about six inches below the jacks for the plugs. A D.P.S.T., S.P.S.T., and a 5-point switch should also be mounted on the front of the box, numbers 8, 7 and 9 in the diagram.

All connections on the jacks, plugs, tubes should be thoroly soldered to prevent leakage. Also the conductor wires and the inside of the box should be coated with paraffine.

Any good kind of paired wire may be used to connect the jacks to the tubes, providing there is some convenient manner of distinguishing between the positive and negative sides. I used No. 22 flame-proof jumper wire which I secured from the local telefone office. It has one white and one black strand, the white always being the positive and the black the negative side. If the battery is to be made successfully, the polarity of the wires must be closely watched, or the battery will be a failure. The easiest way to remember is to always keep the tips of the plugs and jacks positive, connecting the latter with the white or positive strands of the conductor wires, and the sleeves negative, using the black strands. The tipside is the front contact, and the sleeve the rear contact. The best method of wiring is to number each jack, place the corresponding number on a small piece of cardboard and fasten this to the pair terminating in that particular jack. Then the sets of tubes should be numbered the same way and each pair of wires brot to the proper set of tubes. This will become a great deal clearer upon a close study of the diagram. If the diagram is closely followed, the builder should have no trouble in connecting the different parts correctly.

Now as to the charging power: Each cell is to receive 2 volts, 3 amps., and if the following directions are followed, either of two charging rates may be used, these two being 10 v., 3 amp., or 20 v., 6 amp. If the first of these is used, they are charged six sets of five each in multiple, and if the second is used, they are charged three sets of 10 in multiple. The following three paragraphs explain how this is done, and how the discharge is arranged:

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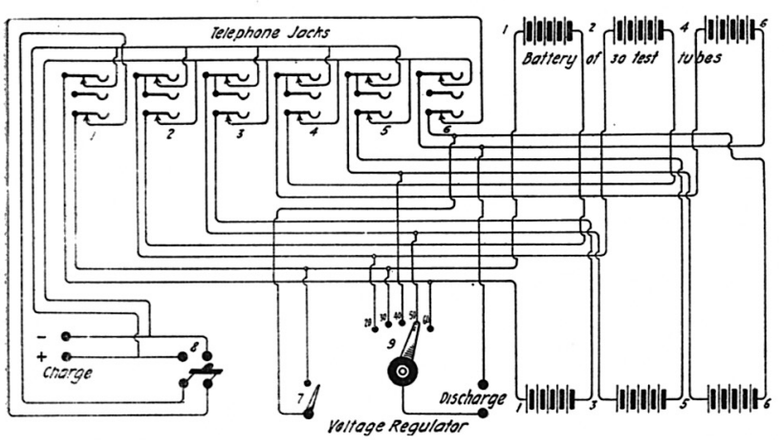

Complete diagram of the variable "B" battery made of test tubes. Note the voltage regulator and the clever system of jacks.

Two Practical Radio Telefone Circuits

By JOHN SCOTT-TAGGART

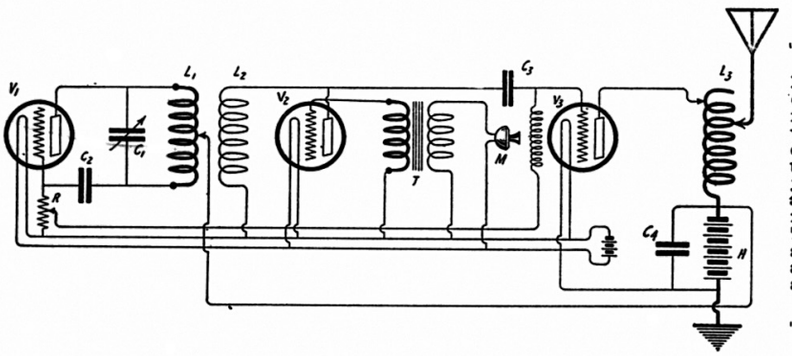

Fig. 1. A very efficient radio-fone circuit in which a master oscillator is used in conjunction with an amplifier and modulator tube. The same A and B batteries are used for all tubes.

THE subject of radio telefony is coming so much to the front that it needs no introduction in articles giving accounts of apparatus which has proved successful in establishing communication over comparatively long ranges, as for example a distance of 300 miles.

The principles on which the circuits here described are based, are at this date not new, but the circuits themselves will, no doubt, be of interest to those whose knowledge of the subject from a practical point of view, is not extensive.

Both the circuits employ the principle of using a three-electrode valve as an amplifier whose output circuit is coupled to an aerial system. This use of the valve is an obvious development of the high frequency amplifying properties of the triode vacuum tube, and the arrangement is frequently employed in radio telefone work.

The circuit of Fig. 1 depends for its action on the use of a three-electrode valve as an absorbing element connected across the input side of an amplifying tube. If steady, continuous oscillations are induced into the grid circuit of such a tube unmodulated amplification takes place. If, however, we cause the microfone in conjunction with another valve, to divert some of the oscillatory energy in a manner proportional to the microfonic potentials, the E.M.F. of the oscillations, in the grid circuit will vary. Consequently, the oscillatory circuit in the aerial will be correspondingly modulated.

In Fig. 1, the vacuum tube V_1 acts as the primary course of continuous oscillations or, as it is sometimes called, the *master oscillator.* The circuits shown for this oscillator are rarely used in England altho they have been frequently employed in France and the United States. A single inductance coil L_1 is shunted by a variable condenser C_1, and the frequency of the oscillations produced is practically equal to the natural frequency of this single circuit. A tapping is taken from about the middle point along L_1 to the anode or plate battery or D.C. generator H and thence to the filament. The condenser C_2 is the grid condenser.

The grid leak R has a value of about 10,000 ohms. It should preferably be wound with resistance wire and have tappings. When such a system oscillates, the grid at every positive H.F. half-cycle absorbs an electron current of several milliamps which results in a comparatively steady potential drop along the resistance R. This potential drop gives the grid of the first valve a suitable negative operating potential.

The oscillations in L_1 are now passed on to a coil L_2, constituting the grid input circuit of the amplifying tube V_3. The condenser C_3 acts as a blocking condenser. The grid of V_3 is connected thru a choke-coil Z to a point on the grid leak R of the first valve. A suitable negative potential is in this way communicated to the grid of V_3. The choke-coil Z is to prevent this potential communicating circuit shorting the oscillatory current in L_2. The coil Z is preferably an air-core choke of high inductance. Its natural period of oscillation should preferably equal the frequency of the oscillations supplied by V_1. Under these conditions, the choke will have a maximum impedance. Auto-transformer connections are shown in the anode of plate circuit of V_3. The tapping from the anode to the coil L_3 enables the output impedance to be varied and the maximum power to be obtained. The tapping from the aerial will vary the tuning of the aerial circuit which, of course, should correspond to the oscillation frequency employed.

The circuit, so far considered, would act as a continuous wave transmitter and a key might be inserted so as to break either

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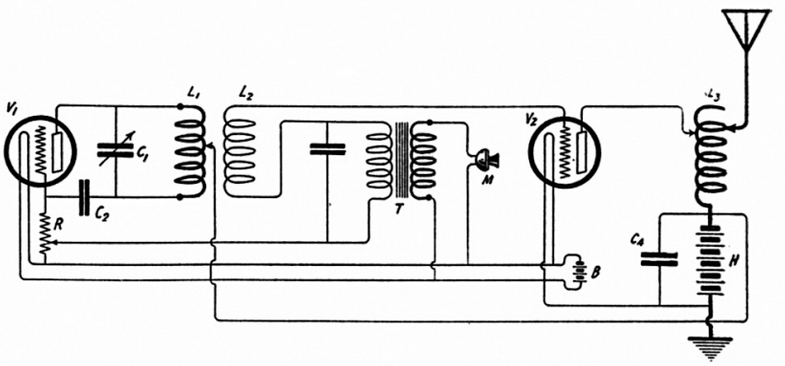


Fig. 2. In this circuit using only two tubes the output of the amplifier is controlled microfonically and gives a clear modulation. An experimental set of this type may easily be built by the amateur.

How to Wind Duo-Lateral Coils

By WM. T. PRATHER

AS is well known, the difference between honeycomb coils and duo-lateral coils is in their winding. In winding honeycombs, consecutive layers are spaced so that the turns of the second layer fall directly over the turns of the first layer, while in the duo-lateral wound coils the turns of the second layer fall over the space between the turns of the first layer. The turns of the third layer then fall directly over those of the first layer and those of the fourth layer over those of the second and so on. Like honeycombs these coils may be wound around pins fixt in a tube, but in the case of the duo-laterals twice the number of pins must be used.

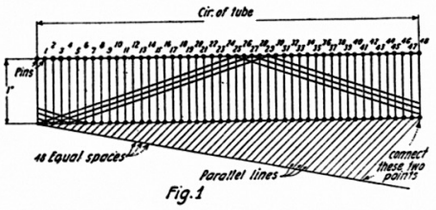


Fig. 1

For the Ham Who Builds His Own, But Has No Winding Machine, Here is How to Wind D. L. Coils by Hand.

First purchase a two-inch mailing tube from a bookstore. Make a wooden dowel to fit into the tube or, if the tube has fairly thick walls, this will not be necessary as the pins will be held firmly enough by the tube. Next determine the position of the pins.

For a tube 1⅞ inches in diameter 96 pins are needed, 48 on each side. An easy method of dividing the circumference into the desired number of spaces is shown in Fig. 1. Draw a rectangle whose length is the exact circumference of the tube and whose width is the width of the coil to be made. In this case it is one inch. From one corner draw a line as shown and mark off 48 equal spaces on it with a ruler or compass. Connect the last mark with the corresponding corner of the rectangle. When lines parallel to this line have been drawn from the equally spaced marks to the bottom of the rectangle and lines continued from these marks have been drawn across the rectangle as shown in the figure it will be found that the rectangle has been divided into 48 equal parts. This method will serve for any size rectangle to be divided into any number of parts.

The drawing is then placed on the tube and the pins put in their places. By winding the coil at one end of the tube the remainder will serve as a handle while winding. Start the winding by taking a turn around one of the pins. Then lead the wire around the 25th pin on the opposite side, then back to the second pin on the first side, then to the 24th pin on the other

(*Continued on page* 553)

Amateur Radio and Its Future

BY PIERRE H. BOUCHERON

TWELVE years ago while traveling on one of the New York "L" lines I gazed for the first time upon one of the few amateur aerials in New York City. Alas, my doom was sealed and the next day I was stricken by the violent sting of the "radio bug."

Back in those "early ages" of amateur radio there was something like five or six stations in New York City. Indeed, they were few and far between. Perhaps some of you may have heard of these pioneers. There was Vermilyea who signed "VN," Cannon who signed "CC," Eltz who signed "GE," Lemmon, Runyon and the dear old "Dad of Radio," Dr. Hudson, who died recently.

Amateur radio lost a great friend, for he had been intensely interested in this subject up to the time of his unfortunate death.

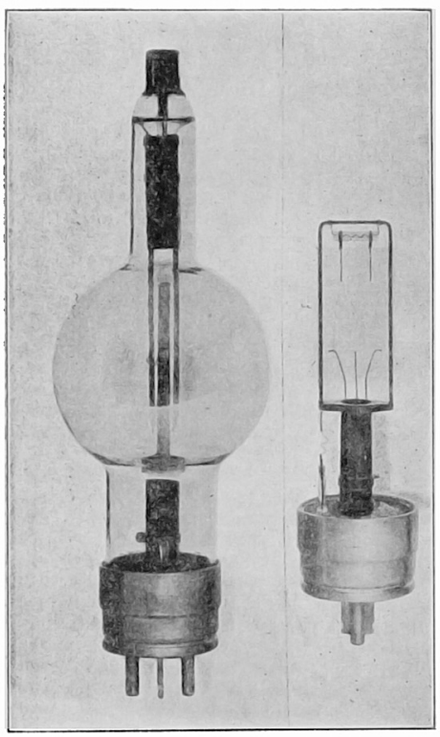


Fig. 1. The Last Word is Power Tubes. This One, Which is 15 Inches Long, is of the 250 Watts Type and Will in the Near Future Replace the Spark Sets of Medium Power. On the Right is a View of the Frame Supporting the Filament and Grid.

Amateur radio of 1907-1908 was of an entirely different aspect from the radio of today. There being so few amateurs in the United States they were not considered very seriously by the authorities for neither the Navy nor the commercial companies had enough stations in operation to bother about the use of special non-interfering wave-lengths.

Those were indeed the good old days of radio. The ether was used in a happy-go-lucky fashion with no thot of tuning or bothering about the decrement and the larger amount of power available the better. If one had a thousand dollars or more to spend for a transmitter, very well it would be a 5-kilowatt "coffin-type" transformer and the more interference it caused the more notorious became the owner.

In other words, the more etheric noise he made the more prominent he was in the locality.

AMATEURS OF EARLY RADIO DAYS

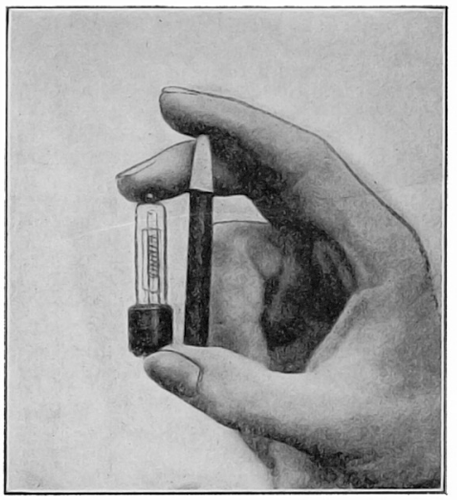
I particularly recall a set of wealthy amateurs residing in the upper part of New York all equipt with powerful transmitters ranging from ½ to 5-kilowatts and who so controlled the air in the vicinity of New York as to have the few commercial stations completely at their mercy, so to speak.

If John Smith felt that he had not asked enough "How is my spark now, old man?" that particular evening, the Old United Wireless Station, "N. Y." would simply have to wait until the agony was over before the operator could proceed with the clearing of traffic between the few incoming and outgoing vessels.

Finally a much needed change came about. More and more young boys and young men were attracted to the fascination and romance of radio until there was such a large number of them as to cause serious interference with naval and commercial radio stations which, of course, were also increasing in numbers.

My word! what work we used to do in those days with a one-inch spark coil connected directly to aerial and earth with no capacity and inductance other than the natural one existing between the antenna and ground, and yet we were able to cover what in those days was considered very good distances of 40 miles or more.

As for receiving—our Perikons and Galena detectors and our poor receiving equipment brot in signals within audibility up to 1,000 miles distant and more. Meanwhile our friend Dr. DeForest was plugging along upon the development of his world-famous audion.



This Lilliputian V.T. Represents the Latest Development in Detector Tubes. Note the Difference in Size Between This One and the Power Tube of Fig. 1.

Very few thot seriously of radio in those days, that is to say, it was considered an excellent pastime, but as for choosing it as a future career—not many entertained the thot seriously.

The more adventurous spirits, however, used it as a means to an end for the sea held out plenty of excitement and thrills. Secretly, if not openly, it was the desire of most of these pioneer amateur men to become seagoing operators.

Then came the more stringent laws which regulated both the amateur body as well as the commercial operators. A great deal of cramming of radio books was done in order to pass the much dreaded examinations. Our friends in the Brooklyn Navy Yard dismantled ponderous and obsolete radio sets including the armatures of their motor-generators, short circuited hot wire ammeters, plugged in a few burned-out fuses here and there, criss-crossed connections, inserted a few extra and misleading pieces of apparatus for good measure and told us to go to it and *make the set work.*

(*Continued on page* 542)

An Old Idea Exploded

BY Dr. GORDON D. ROBINSON*

IT is a matter of common knowledge that the "soft" vacuum tube is an excellent detector. Many people believe that on the contrary the "hard" tube is much superior as an amplifier. The following article tells of a series of tests which indicate that at least one of the soft tubes recently offered for sale to the amateur gives excellent results as an amplifier.

The circuit used was substantially that of Fig. 1, the only difference being that the circuit shown was supplemented by a three-pole double-throw switch which permitted the audibility meter and fones to be inserted in the position shown or to be substituted for the primary of the amplifier transformer. This permitted the set-up to be changed from simple detector to detector and one-step amplifier almost instantaneously, and at the same time avoided errors which might have crept in if different fones had been used. The soft tubes under test were provided with standard four-point bases so that they were readily interchanged with a number of hard tubes.

High amplification in this circuit depended upon critical adjustment. It was found that the value of filament current used was not highly critical. Various values from the 0.5 amperes recommended by the manufacturers down to 0.47 amperes

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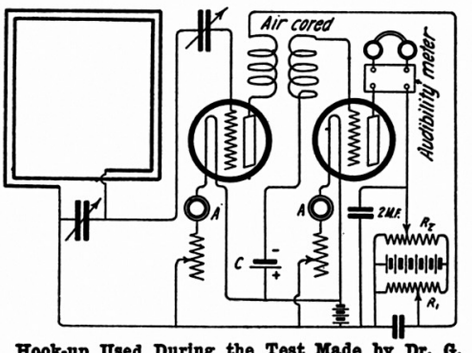


Hook-up Used During the Test Made by Dr. G. D. Robinson on the Efficiency of Soft Tubes Used as Amplifiers.

*Asst. Prof. Dept. Elect. Eng. and Physics, U. S. Naval Academy.

The Arc or Continuous Wave Transmitter

By J. DONALD HAIG

An Elementary Talk on Arc Transmission

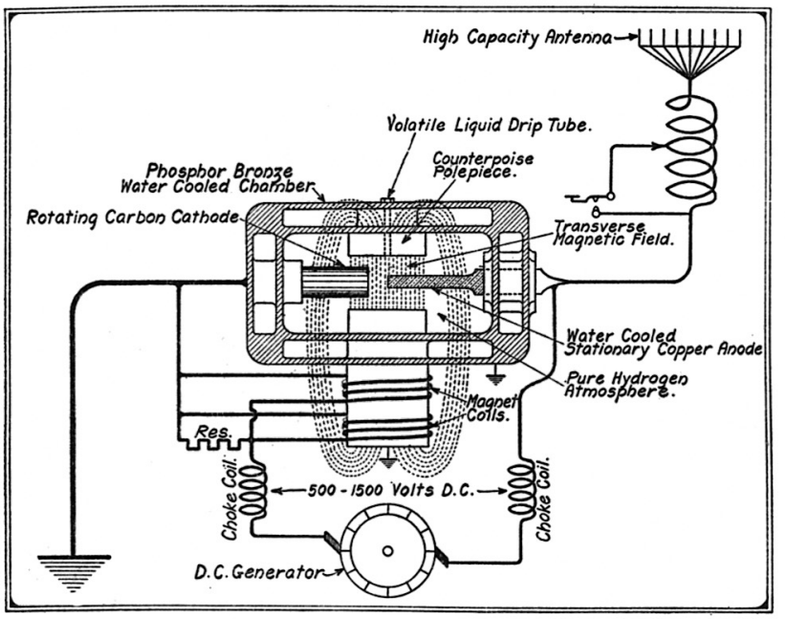
A GREAT deal has been said about undampt receiving in the various radio periodicals but I have noticed but very few articles touching on arc transmitters, and these have been of a highly technical nature; so in the following I will try and start in on the ground floor.

In the first place the word CONTINUOUS wave is confusing, as a matter of fact, is erroneous and UNDAMPT is more suitable for the waves are not continuous.

The wave trains are continuous, however, in that they are of undying amplitude. The frequency of the oscillations is around one hundred thousand cycles per second while the audibility of the human ear only reaches a frequency of in the neighborhood of twenty thousand cycles per second. It is said that there are some species of tropical birds that can hear sounds out of audibility of the human ear.

Those of you who have operated an undampt receiver know how the pitch of the incoming arc signals can be varied to suit the ear of the person receiving and how, on a certain adjustment of the tuner coupling and tickler coil, the pitch will go up until finally it fades out altogether or in other words goes out of audibility of the ear. Incidentally it goes out of range of the natural period, or rate of mechanical vibration of the telephone receiver diaphragms, which after the frequency reaches a certain high rate, fail to keep in step with it and do not respond at all. Therefore in order to receive arc it is necessary to lower the frequency by the use of either a tikker which is a machine for making and breaking the detector circuit at a slow rate or an oscillating audion which gives a much better tone and is a great deal more efficient.

In the arc receiver, the audion is used as a generator of undampt waves; that is it sets up high frequency oscillations in the receiver which are superimposed upon the incoming high frequency oscillations. The difference between the two frequencies will be the pitch heard by the receiving operator providing of course it is within the range of audibility. For instance say the distant arc station sends out impulses of the order of one hundred thousand cycles per second, and you tune your receiver circuits so that your audion generates a frequency of ninety nine thousand cycles per second, then the frequency in the phones will be one thousand cycles per second. This resultant frequency is called the *beat frequency*. In this instance the two frequencies were in step one thousand times or one hundred cycles apart. This is the reason that arc signals can be received at almost any desired note. The frequency of the audion circuit can be altered by varying the coupling and tickler feed-back coil. The faster the audion oscillates the lower will be the received note and visa versa.



Elementary Circuit Diagram of a Continuous Wave Transmitter Employing the Arc. During Transmission the Arc Is Constantly Radiating, and Telegraphing Is Accomplisht by Means of a Key Which Rapidly Changes the Emitted Wavelength.

THE TRANSMITTING SIDE.

Now to get back to the transmitting side of it, let us refer to Figs. 1 and 2. Fig. 1 shows a very elementary circuit of a direct current generator supplying current to an arc; this is an impossible hook-up but serves as a starter.

Fig. 2 shows a vertical oscillator with a spark gap in the circuit. The base of both vertical oscillators are grounded. According to an old theory introduced by Professor Hertz, if this vertical oscillator is excited by an induction coil or other agency the current values and potential strain at points along this antenna or oscillator will be represented as shown graphically in Fig. 2, wherein the dotted line represents the potential values and the solid line the current value at each point along the oscillator. For this reason hot wire ammeters are always put in the ground lead as near as possible to the ground which is to protect the instrument against excessive potentials and this is the point at which there is maximum current. This is proven by the fact that one can grasp the ground lead at the point at which it is grounded and not experience a shock and yet the radiation ammeter will give a reading.

Now let us take a higher oscillator or aerial circuit as illustrated in Fig. 4 which shows several oscillations running up and down the antenna circuit. In this example the maximum potential comes at the free end of the oscillator. This is often the case in actual practice and the reason that commercial wireless companies put additional insulators in the free end or the end opposite the rat tail end or in the case of a T antenna there is equal strain on each end of the flat top. The greatest strain occurs at points where there is a potential loop. This fact is noticeable by brush discharges taking place across turns of inductance or other points in the open circuit that continually break down. Sometimes by changing the tuning these weak points can be changed to another point in the circuit which will not break down as easily. Let us step aside and look at Fig. 5 which shows mechanical vibrations set up in a reed or in a steel wire stretched between two points, and also shows graphically the oscillations set up in an electric wire of a certain electrical length. In radio the practice is to express this length in meters, but it can just as well be exprest in feet. The points at which there is no movement are called nodes, while the points at which there is maximum movement are called loops or anti-nodes. It will be noted that the point of support of the vibrating member where it cannot move must in every case be a node. In other words, the point at which the open circuit of a radio is grounded is a node. Since the electrical impulses consist of variations of current and potential which succeed each other at intervals, and since at a given point we find a loop of potential and a node of current, we must, at a quarter wavelength distant, find a node of potential and an anti-node of current. The longer the mechanical length or electrical wavelength, the longer time it will take the oscillations to traverse the path of the oscillator. Just the same as the longest string on a piano gives the lowest note or vibrates at a lower frequency than any of the rest, while the shorter strings give off the high pitch notes, the mechanical oscil-

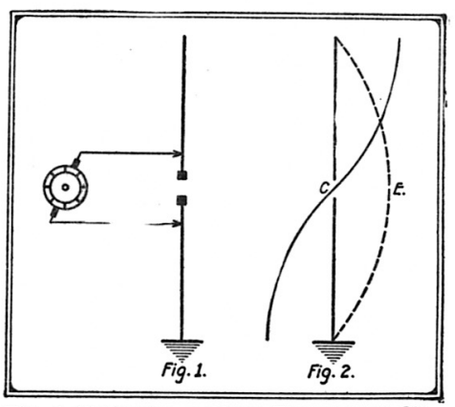
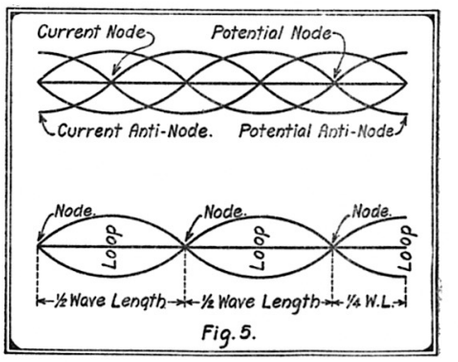


Fig. 1 Illustrates a Very Elementary Circuit of a Direct-Current Generator Supplying Current to an Arc, While Fig. 2 Shows a Vertical Oscillator with a Spark Gap in the Circuit.



Graphic Illustrations of the Oscillations Set Up in a Charged Wire of a Certain Electrical Length. The Points at Which There Is no Electrical Movement Are Called Nodes, While Those of Maximum Movement Are Called Anti-Nodes.

lations can run up and down them in a much shorter period of time. When we speak of time in radio, especially arc oscillations, we divide our time into one hundred thousandths of one second.

This is the principle that underlies the arc transmitting oscillating circuit, and explains the tuning of the radiating circuit by adding or decreasing inductance, thus altering the length of the path over which the oscillations travel, not only changing the wavelength but also the frequency of the circuit. The frequency after all is the time required for one oscillation to travel from the ground to the free end of the antenna and back to earth again. This whip-like action at the free end is the cause of the high strain on the insulation at the free end of the aerial.

AERIAL FORMS ONE SIDE OF CONDENSER.

Fig. 6 shows a simple arc circuit and arc antenna which consists of a greater number of wires in the flat top portion than in the spark type. This is to give a greater value of capacity and to form one plate of a condenser, the ground being the opposite plate and the intervening air space the dielectric of this huge condenser. On shipboard arc installations the antenna generally consists of a ten wire flat top aerial swung between twenty-foot. spreaders, while for spark work either four wires on fifteen-foot spars or for a two wire aerial ten-foot spreaders are the standard. On some battleships the small diameter cage sometimes known as sausage type aerials are used. These have the advantage of occupying a relatively small space without much loss of capacity. Also for the arc it is necessary to employ more than twice as much insulation in the aerial halliards to hold the pressure of the high voltage high frequency power than it is for spark transmitters.

From the foregoing it is seen that the arc antenna is a well insulated condenser plate and the earth or steel ship underneath it is the other plate. Inserted in the path between these two plates is the tuning inductance or loading coil.

Upon applying power to the arc electrodes this huge condenser is charged by the direct current which is supplied to the arc terminals; that is, by direct current at the first impulse of the arc when it is struck or lit. This, however, changes instantly to a high frequency oscillating current. By instantly we mean something less than one hundred thousandth of a second.

Now let us look at the power and high tension circuits. The prime power source generally consists of a 500 volt or higher direct current generator, both the positive and negative feeders are run thru iron choke coils and also thru arc magnet coils which aid the chokes in holding back the high frequency surges and also produce the transverse magnetic field in which the arc burns. The negative lead is secured to the ground side of the arc or to the cathode which is a carbon electrode. I might mention that the negative lead is always the grounded side in all electrical work where a ground is used. For instance, on electric traction lines the rail is the negative side,

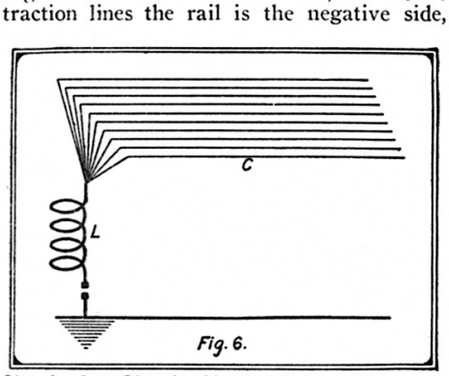


Fig. 6.

Simple Arc Circuit, Having Large Antenna Sufficient to Form One Side of the Condenser, While Ground Forms Other Side.

also on telephone and telegraph common returns, etc., or in other words it is standard practice to consider the ground as the negative quantity. The positive lead goes to the antenna side of the arc gap which is a copper electrode and is called the anode. The high tension circuit, as you see, has capacity between aerial and ground and inductance in the tuning coil. It is a circuit having capacity and inductance and is therefore a natural oscillatory circuit. There have been many theories advanced concerning just what action causes an oscillatory action to be set up by the direct current arc, but I believe there has been no acknowledged explanation accepted to date, as there is no way of finding out exactly what takes place. In the following I will set forth one which seems as feasible as any.

WHY THE ARC TRANSMITS.

When direct current is fed to the arc the antenna and ground also accumulates a charge and this robs the arc of a part of its current, since the supply current is kept constant and cannot reverse back into the generator on account of the choke coils which protect the direct current generator. If the current in the arc decreases, it is clear that the voltage at its terminals must increase. Figure 2 shows maximum voltage at E and minimum current at the arc C, Consequently as long as the charging of the antenna-ground continues, the voltage will rise. As soon as the condenser becomes fully charged, the arc voltage becomes stationary. Then the condenser begins to discharge itself through the arc, thereby increasing the arc current again and reducing the arc voltage. This will continue until

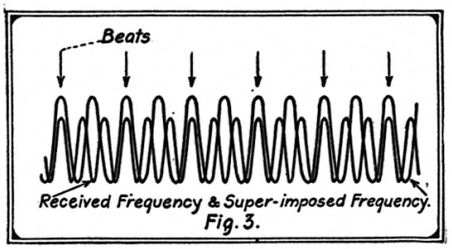


Fig. 3.

When an External Frequency Is Superimposed Upon the Received Frequency the Phenomena of "Beats" Occurs, Providing the Two Frequencies Have Different Values.

we have a minimum voltage and a maximum current in the arc. The discharge of the condenser will continue or swing past the point of zero current. Thus the condenser will become charged in the negative direction until the arc voltage falls so far that the supply voltage of the direct current supply leads causes a reversal of the whole action or cycle. Thus high frequency oscillations are built up, this whole process only occupying one hundred thousandth of a second.

The name *arc converter* is derived from the fact that direct current is converted into high frequency alternating oscillating currents. The arc is very efficient considering the fact that the signals have the same audibility at over four times the distance of an equivalent input of spark transmitter. The arc can be used to far better advantage for long wave transmission and is far more selective than spark. The absorption by the sun's rays is practically negligible, there not being really much difference between daylight and night time transmission. The circuits of the arc are comparatively simple, tuning being effected by adding or decreasing series loading inductance, there being no closed circuit. With this system it will be seen that after power is applied to the arc electrodes and the arc is struck, opened up until the proper gap is obtained, that the direct current circuit cannot be opened up without extinguishing the arc.

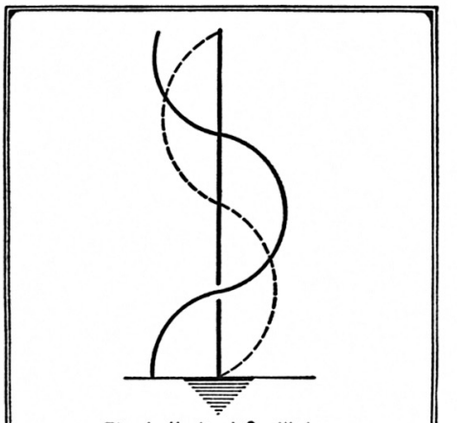


Fig. 4. Vertical Oscillator.

In This Instance Several Oscillations Run Up and Down the Antenna Circuit. Maximum Potential Comes at the Free End of the Oscillator.

THE KEY CIRCUIT.

As long as the arc must be struck and adjusted each time, it is obvious that the key cannot be inserted in the supply leads, but that the arc must burn continuously thru the transmission period. This is accomplisht by two telegraphing methods called the *wave changing* and *absorbing* systems, the names of which are almost self explanatory. In the former a relay key is used to short-circuit a small portion of the antenna inductance and thus reduce the wave each time the key is deprest. As the wave emitted by the arc is exceedingly sharp, the receiving operator tunes in the low wave or *telegraph wave* and does not hear the back wave at all which sounds like "Chinese." Some arcs are arranged so as to increase the number of turns of inductance when the key is pressed, and in this case the receiving operator has to tune up in order to get the signals that make sense. This system is rapidly giving way to the absorbing system which consists of a dummy antenna or by-pass for the back wave. The oscillations in between the dots and dashes are absorbed to ground thru a dummy inductance and bank of condensers. When the hand telegraph key is prest, it operates a highly insulated relay key which opens up this dummy antenna circuit and allows the current to traverse the main antenna circuit, thus radiating the power into space.

WHY IT IS SOMETIMES POSSIBLE TO RECEIVE ARC ON CRYSTAL DETECTOR.

It is an interesting fact that arc signals can sometimes be copied on low wavelengths when the receiving station is in very close proximity to the arc transmitter. This is probably on account of the reflection or reradiation of the energy on a lower wave or harmonic. In the case of a ship installation from the steel shrouds which retransmit the signals on a lower wave. This also seems to produce a heterodyne effect making the signals audible on crystal detectors. Amateurs living in the rural districts where there is a chance for stringing a one wire antenna thru trees for several thousand feet, or perchance make use of an old telegraph line or phone wire can pick up some of the long wave arcs by the use of a high frequency interrupter in the detector circuit. However, the natural period of the receiving antenna must nearly approximate that of the transmitting undampt station to obtain results with the *tikker,* as nothing short of an audion will bring in the signals if a short antenna is used, too much loading being required. But with the long antenna enough energy can be gathered to be

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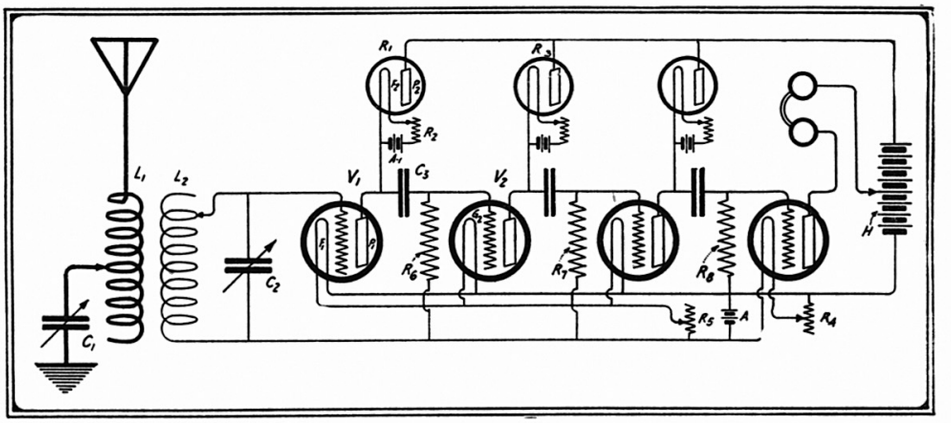
An Amplifier Employing Thermionic Intervalve Resistance Couplings

By JOHN SCOTT-TAGGART



This Amplifying System is Unique in That it Employs Vacuum Tubes as a Means of Coupling Between Each Stage of Amplification.

THE author has devised a large number of amplifying devices in which the coupling between the valves consists not in the usual form of resistances or transformers, but in thermionic couplings. In place of ordinary conductors of high impedance, it is proposed to use a conductive path between the cathode and anode of a vacuum tube such as the Fleming valve.

One form of the arrangement is shown in the accompanying figure, which shows the application of the arrangement to the reception of wireless signals.

An aerial circuit L_1 C_1 is coupled to a closed receiving circuit, L_2 C_2, which is connected across the grid and filament of the three-electrode vacuum tube V_1. The plate circuit of V_1 contains a two-electrode vacuum tube R_1 and the plate battery H. The valve R_1 may conveniently consist of an ordinary three-electrode valve in which the grid and anode are connected together. The filament, it will be noticed, is heated by means of an accumulator A_1, preferably thru the five-ohm rheostat R_2. The electron current from the filament F_1 of the vacuum tube V_1 flows to the plate P_1, to the filament F_2 of the vacuum tube R_1, thence to the plate P_2, and so back to the filament F_1 *viâ* the battery H. The valve R_1 acts as a resistance of the order of 100,000 ohms, which value, however, may be conveniently varied by altering the emission from the filament F_2 by adjusting R_3. We thus conveniently obtain a non-inductive resistance whose value may be very readily varied, and whose normal value approximates to that of the valve V_1—a most desirable condition for effective amplification. By this means the voltage on the grid of V_1 will vary the resistance of V_1, and, consequently, vary the current in the circuit F_1, P_1, F_2, P_2, H, F_1. Since the current thru R_1 is increased, the potential across P_2 and F_2 will also increase. If the grid of V_1 is positive, F_2 will become negative with respect to P_2. By connecting P_1 thru the condenser C_3 to the grid of the second valve, the potential variations across R_1 are impresst on the grid G_2, the condenser C_3 insuring that Grid G_2 is insulated from the high positive value which would otherwise be given to it by the battery H. The momentary negative potential on G_2 increases the resistance of the tube V_2, and so lessens the current in the circuit V_2, R_3 and H. Since the current thru R_3 is decreased, the potential across R_3 decreases, and, consequently, the grid of the third three-electrode valve is given a positive pulse. The third three-electrode vacuum tube acts in a manner comparable to the first. The last vacuum tube is intended to act not as a high-frequency amplifier, but as a detector, and a pair of telefones is included in its plate circuit, a suitable tapping being taken from the battery H.

To assist us in arranging that the last valve shall act as a detector, we can conveniently make its filament current variable by the use of a separate rheostat, R_4. The current thru the filament of the first three vacuum tubes may be varied by means of a rheostat, R_5. These three valves act as amplifiers of the high-frequency oscillations, and are not intended to act as detectors. Resistances R_6 and R_7, having a value of about 4 megohms, are connected as shown and are intended primarily to prevent the accumulation of electrons on the grids of the second and third vacuum tubes. It is to be noted that the grids of the first three valves are connected to the negative side of the filament-heating accumulator; moreover, the rheostat R_5 is so connected that the grids will always have a potential negative with respect to the negative end of the filament. This will tend to prevent the establishment of grid currents in the first three valves.

If desired, the same effect could be produced by using a fixt resistance of about 1.5 ohms in place of the rheostat, R_5, the filament currents being then regulated by means of a rheostat connected between the positive side of the filament and the positive terminal of the accumulator. This latter arrangement is probably preferable.

A high resistance R_8 of about 4 megohms is connected between the grid of the last valve, and either the positive or negative side of the filament accumulator, according to which connection gives the best results.

In addition to the advantages gained by being able to vary each of the plate circuit resistances, the valve resistances R_1, R_2, &c., may be arranged to act as a limiting device, in which case the strength of signals may be easily controlled, and exceedingly loud signals or atmospherics may be cut down by suitably adjusting the rheostats R_2, &c.

The writer hopes in the near future to present a paper on further applications of thermionic intervalve resistances, including devices of practical importance and value. —*London Electrical Review.*

An Undampt Wave Method of Determining Dielectric Constants of Liquids

By W. H. HYSLOP and A. P. CARMAN

THE method makes use of two circuits of the "ultra-audion" type, one operating at a definite frequency and the other tuned to such a frequency that a definite number of beats per second is obtained. The accompanying sketch shows one arrangement of the circuits. Circuit 1, very loosely coupled with Circuit 2, is operated at one frequency thruout a test. Circuit 2, shown in sketch, differs from Circuit 1 in the use of three condensers C_1, C_s and C_x, instead of a single condenser. The condenser C is inserted in order to keep the resultant capacity of the group at the proper value. The condensers C_s and C_1 are air condensers of the Korda type. They were designed and built in the department machine shop especially for this work, and can be reset to any required capacity with high accuracy. The calibration also showed that the capacity from the minimum to the maximum values, varies directly as the angular displacement of the plates. The test condenser C_x consists of two concentric cylinders, and its value is known in terms of the angular displacement of the plates of C_s.

In determining the dielectric constant of a given liquid, the condenser C_x is disconnected, C_s is set to some value near its maximum, and C is adjusted until a beat note of convenient frequency (512) is obtained. This beat note is determined by ear thru comparison with a standard tuning fork. C_x is filled and connected in the circuit; C_s is decreased until the same beat note is heard. The ratio of this angular displacement to that for C_x as an air condenser gives the dielectric constant of the substance tested. For values beyond the

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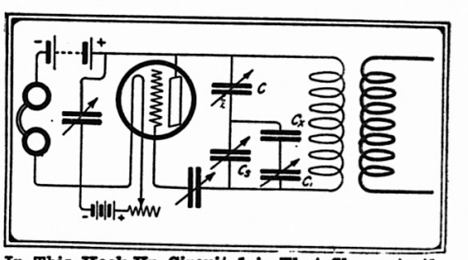

In This Hook-Up Circuit 1 is That Shown to the Extreme Right Consisting of Heavy Outline, While Circuit 2 is That Outlined to the Left.

Controlling By Wireless

By EVERETT LEO DEETER

THE long winter months are again with us and Radio Clubs and individuals are devoting much more time to their instruments and to giving instructive and scientific programs.

Probably one of the most important parts of such programs, and the one presenting the most difficulty, is that of controlling apparatus by wireless. Several methods have been presented by Radio enthusiasts, some of which were very difficult in construction and quite expensive.

Having experimented considerably in connection with Radio controlling apparatus, and having constructed several outfits of varying design, I am presenting one of the simplest of the most successful outfits, with which almost any number of machines or apparata may be controlled at a distance, by radio telegraphy.

The transmitter, which is to control the display, is illustrated by Figure 1. P is a commutator, made up of any number of segments, each of which is connected in circuit by the switches, k. When any switch is closed and the arm makes contact with that segment to which it is connected, the relay R closes and the spark radiates waves from the sending antenna.

Figure 2, the receiving relay, is the method by which the radiations are received and amplified by the Audion Amplifying Circuit, which actuates the sensitive polarized relay R'. This in turn operates the relays (r), respective to which the segment of the commutator on which is the contact arm.

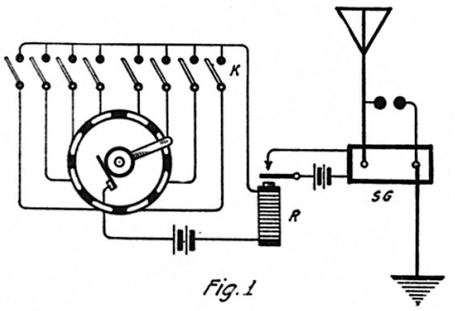

Fig. 1

The Control System at the Transmitting Station is Shown in This Diagram. The Rotary Commutator is Made of Any Number of Segments.

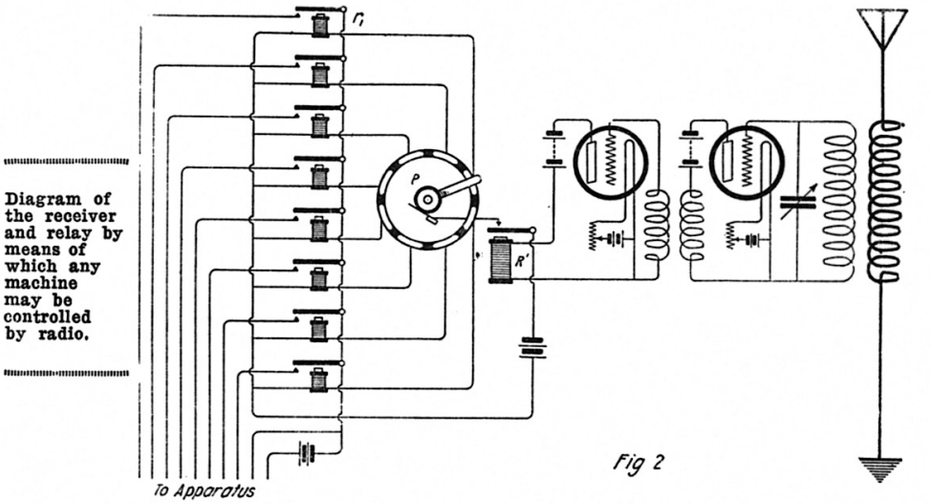

Diagram of the receiver and relay by means of which any machine may be controlled by radio.

Fig 2

The relays r, are constructed as shown in Figure 3. A portion of the core is drilled out and a steel bar, B, replaces it, as shown in the sectional view H and C. The insulation I is secured to the post S by a screw, P is a piece of spring steel. When current passes thru the relay the steel bar becomes permanently magnetized and holds the arm down a short time until it loses its flux. The time should be about one second, and the steel bar in the core can be annealed accordingly.

The arms on the commutators, P, are to run in step, and may be geared to clockworks or a phonograph motor and set to run about one revolution per second. A starter for the receiver may be made by using an electro-magnet to pull back a catch, when magnetized, which turns loose the wheel on the arm shaft. The one on the transmitter may be made the same and connected directly with a convenient switch attached to the commutator. Thus the two arms will start and stop together, or at the same corresponding segment. The receiving starter is connected in circuit with one of the relays r.

A switch closed at the transmitter sends out radiations at the instant the arm passes onto a segment which is connected to a closed switch. This received at the relay end, amplified until it closes the relay connected to the segment of the commutator over which it is passing, is the corresponding one to that of the transmitter. The

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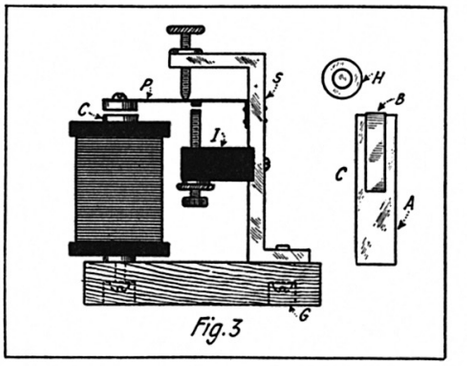


Fig. 3

Constructional Detail of the Relays Closing Each Separate Circuit.

Sparks and Spark Frequency

A Few Notes on the Improvement of Transmitters By Calculation of the Correct Spark Frequency to Be Used

By VINCENT TASSI

WE have heard a great deal and have seen countless articles on the raising of our efficiency and the spreading out of our transmission range by cutting down our resistance losses, by improving our quenching thru the quenched gap or a better designed rotary. We are told to improve our antenna and get better tuning and resonance. But all these factors, no matter to what degree of efficiency you may bring them, do not determine your *power* output, and that is what we are interested in.

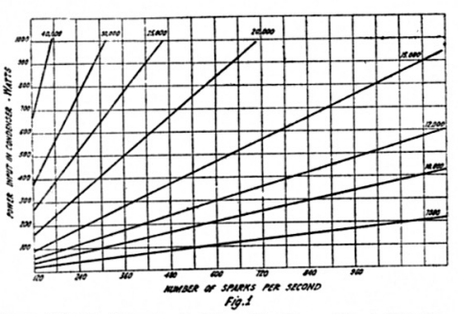


Fig. 1

From These Curves it May Be Seen That There is an Advantage in Using Low Notes for High Secondary Voltage and High Notes for Low Secondary Voltage.

The big trouble is that amateurs have been misled into the belief that a low spark frequency is *the* thing for best work. The conclusion that the low note was better is due to two main causes. First, the low note from a near-by station makes more noise in the receivers, has more of a tendency to "blow" the bulb, and gives all the signs of having more power than the high pitched spark. Secondly, we hear many "DX" stations using the favorite low note, coming thru very QSA. But aren't these fellows using one kilowatt, high voltage transformers? All are not so fortunate as to have a 30,000-40,000 volt transformer, so we must use the superior high note with our conditions. If you think the high note does not come thru, just listen some night for distance. You'll probably find the half-K.W. high notes coming thru over the one-K.W. low ones. We all know the superiority of the high tone in working thru all forms of interference.

Now for the "dope" showing how grossly inefficient the low frequency spark is on lower voltage, lower power transformers. We have the formula for the power input in the secondary condenser

$$P = \frac{NCE^2}{2 \times 10^6} \text{ watts}$$

Where N is the number of sparks per second, C is the condenser capacity in microfarads, E is the secondary voltage of the transformer.

Now let us take the case of an attempt to use a 120-spark note with a quarter-kilowatt transformer having a secondary voltage of 7,000. On all calculations, herein discusst, C will be made .007 microfarads as this is the best capacity for radiation on 200 meters and is the capacity usually found in amateur transmitters.

Substituting the values above we get:

$$P = \frac{120 \times .007 \times 49 \times 10^6}{2 \times 10^6} = 20.58 \text{ watts}$$

(*Continued on page* 578)

Notes on Modulated Tube Transmitters

A. S. BLATTERMAN*

IN a previous article† the writer discusst the relative advantages of different methods of modulation available for use in tube transmitting circuits. The questions there answered contain some which should be of special importance to the amateur. Such for instance is the most pressing one—"Suppose I have two tubes; how shall I connect them for a telefone set in order to get the greatest range? Shall I use both as oscillators in parallel and talk on their grids, or shall I use one as oscillator and one as modulator according to the constant current system?" Or again, "Which is the better, to modulate an oscillator and then amplify the modulated output, or to amplify the output of a single oscillator and then modulate?"

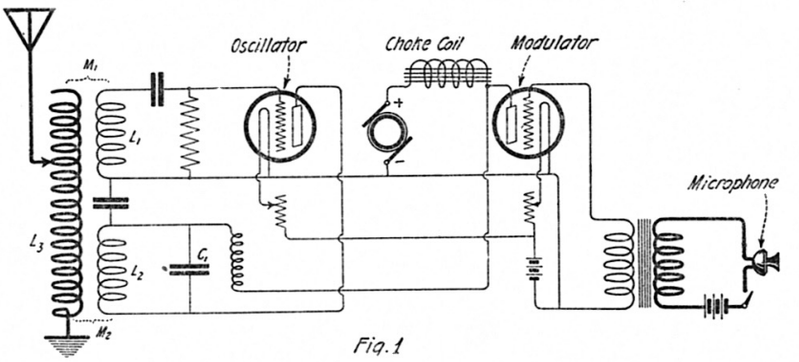


Fig. 1

A Radiofone Circuit Using One Tube Modulator and One Tube Oscillator, and Giving a Uniform Output on the Entire Range of Wave-Length.

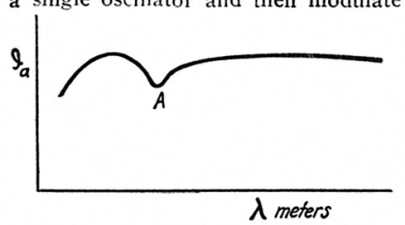


FIG. 2.

Output Characteristic of the Circuit of Fig. 1. The Dip in the Antenna Current at A May Be Shifted to Any Wave-Length.

The amateur, like every engineer, is after efficiency. He wants the greatest range and the clearest talk with smallest money outlay both originally and for upkeep; and generally since he is not hindered by such matters, as patent considerations, organization policies, production troubles, questions of portability, weight, extreme ruggedness, waterproofness, antenna visibility, good earth connections, etc., he ought to have it.

THE BEST TYPE OF CIRCUIT

In the article above referred to, it was shown that the constant current system of modulation was superior to other systems there classified as, diverting or detuning systems, absorption systems, grid modulation; and these theoretical conclusions are entirely in accord with the latest practice of the U. S. Signal Corps, the Navy and commercial companies whose best sets use the constant current type of modulation. When only two tubes are available it is best, without question, to use one as an oscillator and one as modulator. In this case the circuit shown in Fig. 1 will be found to be somewhat better than the usual split capacity or inductance circuits. The output is more nearly uniform over the entire range of wave-lengths for which the set is designed and somewhat greater than that from the above mentioned circuits unless the different elements of the latter are all made adjustable. The circuit of Fig. 1 requires only one adjustment which is that on the antenna inductance. This automatically takes care of the required changes in coupling as the wave-length is changed if the coils are properly designed.

The output characteristic of this circuit is shown on Fig. 2. The dip in the antenna current at A may be shifted to any wave-length by adjustment of the condenser C_1 and if desired may thus be thrown entirely out of the range of wave-lengths to be used. Once C_1 has been adjusted it is left fixt.

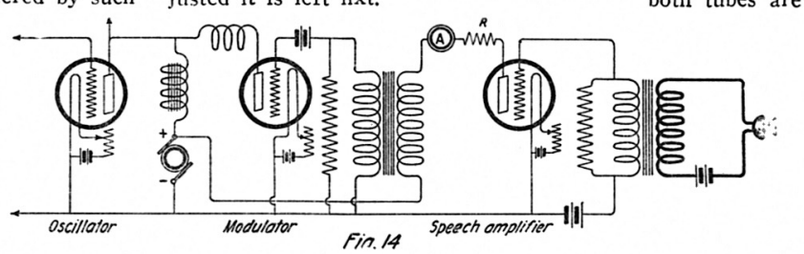


Fig. 14

Diagram Showing How a Speech Amplifier is Connected in the Circuit to Give the Necessary Modulation Amplitude When Several Tubes Are Used as Oscillators.

The coils L_1 and L_3 are wound on the same form, as shown on Fig. 3. L_2 is wound on another form within L_1 and L_3.

This type of circuit, in common with all others in which the antenna forms part of the main oscillating circuit, has the serious drawback that the frequency or wave-length is effected by variations in the antenna circuit such as swaying of the antenna in the wind or even movements of the operator's body or hands in the vicinity of the circuits. When telegraphing by the heterodyne method at such short wave-lengths as 200 meters this is particularly noticeable and troublesome, since it causes the beat note to waver, and even for telefony it may be serious in causing swinging or fading of the signals.

It is much better, especially for amateur working where relatively short wave-lengths are involved, to use a type of circuit in which the antenna has no effect upon the frequency or wave-length radiated. The scheme for such a circuit is shown upon Fig. 4 and suitable details in Fig. 5. It is seen that the wave-length may be set by adjusting the variometer in the master oscillator circuit. The oscillations in this circuit are amplified by the amplifier circuit and then passed to the antenna. Any variation in antenna conditions cannot affect the wave-length radiated because this is fixt by the master oscillator circuit. The antenna is tuned to this wave-length by means of its variometer and should its capacity change, the antenna current simply falls slightly, due to the detuning; but the wave-length remains unaltered.

The question will at once be raised, "Can as much power be obtained from this arrangement as if both the oscillator and amplifier tubes were used in parallel oscillating directly into the antenna?" The answer to this very pertinent question is in the affirmative. If two tubes are to be used, the same power can be obtained by the master-oscillator-amplifier connection as if both tubes are used in parallel as oscillators. If more than two tubes are to be used then the oscillator-amplifier arrangement will give more power than if all tubes are used as oscillators. One of the tubes in this case will serve to excite three or four others as amplifiers. In addition it is possible to secure better modulation by the oscillator-amplifier arrangement, as in Fig. 5, than by modulating a self-excited oscillator.

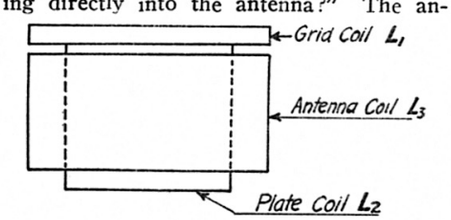


FIG. 3.

Diagram Showing the Method of Coupling of the Different Circuits of the Hook-up in Fig. 1.

These considerations therefore indicate the most satisfactory type of circuit as one comprising a master oscillator, an amplifier, and constant current modulation applied to the plate circuit of the latter. This is the type of circuit which will now be discusst more in detail. There are a number of

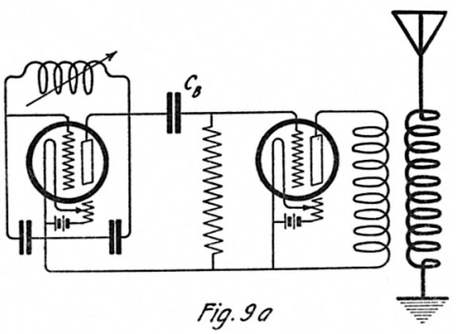


Fig. 9a

This Shows How the Amplifier is Coupled to the Master Oscillator. The Condenser C.B. is to Keep the Plate Voltage Off the Grid of the Amplifier.

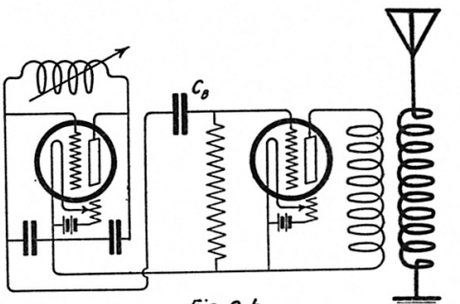


Fig. 9b

This Circuit as Well as in Fig. 9A is Especially Efficient When Only One Wave-Length is Used.

*Radio Engineer, Camp Alfred Vail, N5.
†Radio News, Dec., 1920; Jan., 1921.

points concerning the practical design and adjustment which must be understood in order to secure proper operation.

AMPLIFIER EXCITATION

By the term "Amplifier Excitation" is meant the alternating voltage impresst upon the grid of the amplifier from the master oscillator circuit. For telegraphing the value of this excitation voltage is not of great importance provided of course it is sufficient to get all the possible output from the amplifier. For telefony, however, the proper excitation must be provided or distortion and reduced effectiveness will result. With under-excitation the modulation will be more downward than upward

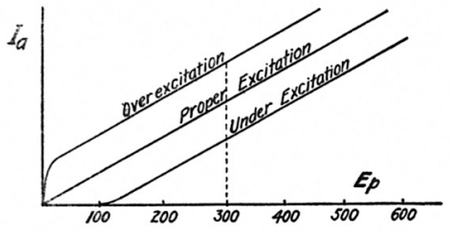


FIG. 8.

Three Conditions That May Exist in the Radiofone Circuit. With Both Over and Under Excitation Distortion of Speech Happens.

as indicated in Fig. 6. With over-excitation the modulation will not drop to zero as rapidly as it should. There is a certain value of excitation which will give uniform modulation upward and downward as shown in Fig. 7, and this is the condition which is most desirably produced.

The best way to determine whether or not the proper excitation is being used is, of course, to look at the modulated antenna current by means of an oscillograph. Before this is done, however, a certain curve about to be described may be taken which will give important indications as to the correctness of the excitation. In order to take this curve, arrangements should be provided for changing the amplifier plate voltage while maintaining that on the oscillator constant. In this way the oscillator high frequency current may be kept substantially constant while the amplifier plate voltage is varied. The curve in question is plotted between antenna current and amplifier plate voltage under the condition of constant excitation. Fig. 8 shows three possible conditions which may be found to exist, corresponding to over-excitation, under-excitation and proper-excitation. The action of the modulator is to vary the plate voltage of the amplifier and the utility of a curve such as those of Fig. 8 thus become apparent. If the normal operation is at 300 volts, then the modulator will cause

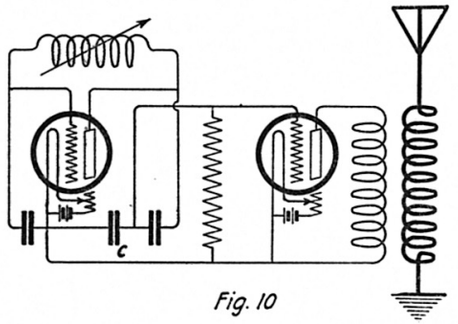


Fig. 10

In This Circuit the Correct Value of Coupling is Obtained by Adjusting the Value of the Condenser C Until the Amplifier Excitation Remains Constant for All Wave-Lengths.

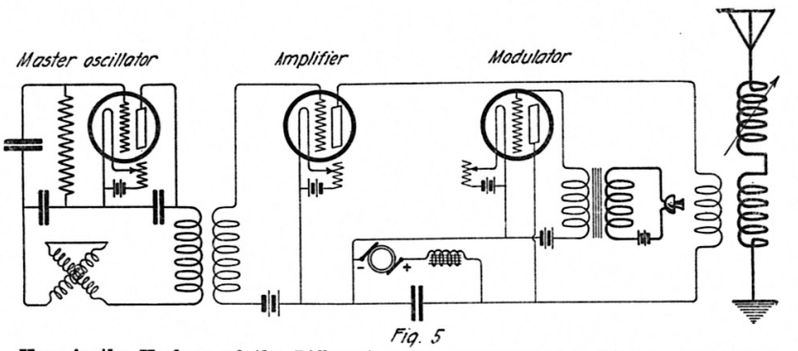


Fig. 5

Here is the Hook-up of the Different Parts Arranged as in Fig. 4. The Wave-Length is Adjusted by the Variometer in the Master Oscillator Circuit.

the plate voltage to vary (approximately) from 0 to 600 volts and for proper modulation the antenna current should change in direct proportion. If there is not sufficient excitation it will be seen that the antenna current will reach zero long before the plate voltage, causing distortion. Similarly if the excitation is too great, distortion will also be present and the modulation generally incomplete. The straight line characteristic is the one to be sought for.

There are numerous obvious ways of coupling the amplifier grid circuit to the master oscillator. Thus, assuming that the split capacity type of oscillator is used, the grid-filament circuit of the amplifier may be tapt off across the plate condenser of the oscillator (Fig. 9a) using a blocking condenser CB to keep the positive plate voltage off the grid of the amplifier and give the right coupling for proper excitation of the latter. Or, as in Fig. 9b, the voltage across the grid condenser may be used. For one particular wave-length,

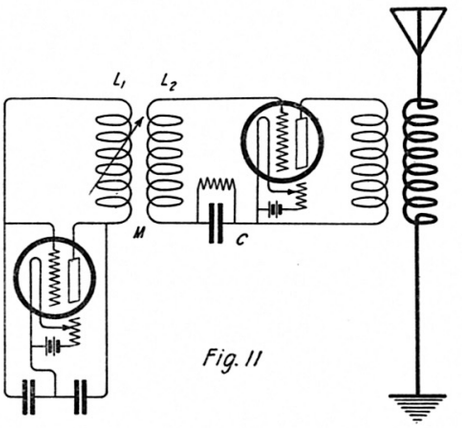


Fig. 11

Another Arrangement by Which Constant Proper Excitation May Be Had for All Wave-Lengths.

either of these arrangements may be satisfactorily employed but when a set is to cover a range of wave-lengths it will generally be found, on account of the reactance of the condenser CB (which condenser must be relatively small to avoid serious short-circuiting effect on the oscillator by the grid circuit of the amplifier) that the excitation voltage between grid and filament of the amplifier changes when the wave-length is changed. An adjustment giving proper excitation for one wave-length may therefore not give at all the proper value for another wave-length.

This difficulty may be overcome by the connection of Fig. 10. Here the necessary looseness of coupling obtained in the previous circuits by condenser CB is now provided by correctly adjusting the condenser C. If now the oscillator circuit is adjusted so that the high frequency current generated increases and decreases in direct proportion as the frequency is increased and decreased, the voltage across C, i. e., the amplifier excitation, will remain constant for all wave-lengths. Such adjustment can be made in practice without difficulty and this circuit is therefore to be recommended for telefony.

Another arrangement by which constant proper excitation may be had for all wave-lengths is that of Fig. 11. Condenser C in this circuit is made very large so as to have negligible reactance at all radio frequencies. Similarly coil L_2 is given small inductance so that its reactance is negligible. It is wound in inductive relation to L_1 which latter is in the form of a variometer. The excitation voltage is then $2\pi fMI$ and to remain constant with changes in f there must be a compensating

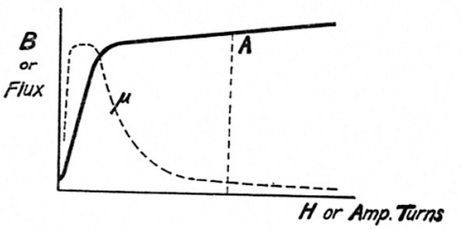


FIG. 12.

Curve of the Flux and Permeability in the Iron Core of a Choke Coil.

change made in M. By proper design this can automatically be taken care of, since the frequency is increased by opposing the coils of variometer L_1 and this reduces the mutual inductance M on the secondary L_2. Similarly when the coils of L_1 are added the frequency is lowered and the mutual inductance on L_2 increased. In practice this arrangement is somewhat superior to those previously described since the load (amplifier grid circuit) is introduced into the oscillator circuit more advantageously and without disturbing the relative phases of grid and plate voltages of the latter. Still other devices for securing the desired proper excitation for telefony and correct functioning of the circuits independent of wave-length, are available and are in use by the Signal Corps at their Camp Vail laboratories, tho legal considerations prevent their description at the present time.

CONSTANT CURRENT CHOKE COIL

A popular idea has arisen that the iron core choke coil, used in the so-called constant current modulation system, is in fact a device which actually maintains the total current to oscillator and modulator substantially constant, or at least should do so and hence should have as large an inductance as possible. This idea is fallacious. If R_o represents the internal plate-filament resistance of the oscillator and R_m the similar resistance of the modulator, it may be

(Continued on page 573)

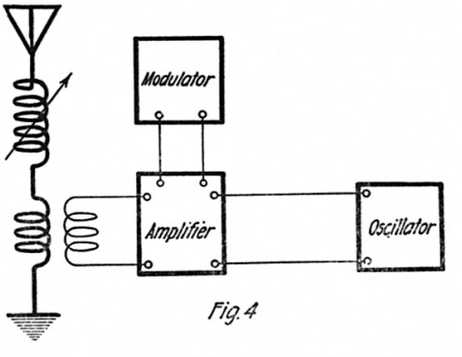


Fig. 4

For Short Wave C.W. Transmission This Arrangement Avoids the Antenna to Have Any Effect Upon the Frequency of the Wave-Length Radiated.

A Simple and Efficient Short Wave Regenerative Receiver

By FREDERICK J. RUMFORD, R.E.

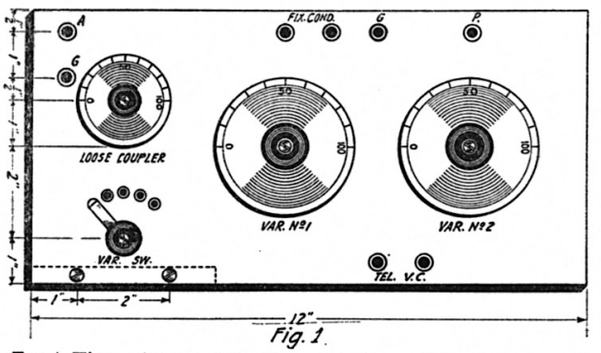


Fig. 1

Front View of the Short Wave Receiver. The Arrangement of the Dials and Switch Gives to This Apparatus a Very Commercial-Like Appearance.

AT last it is here—a short wave regenerative receiver which can be constructed by the amateur very economically. When the outfit described below is carefully made up, it is a credit to an operating table and is one that the most exacting of radio fans will take great delight in showing his friends and fellow bugs. It is easily made up, requires but very few parts, and is so assembled that it is easily accessible at all times for the changing of hook-ups. The builder has his choice of mounting the outfit, which is designed along the lines of the famous Paragon short wave regenerative receiver, in cabinet form or assembling it upon a pair of braces or brackets. It has not been put to any extensive test but has worked on 100 to 400 meters with very good results, and I feel sure that the builder can get still better results by further experimentation.

ARTICLES NEEDED

In making the outfit one needs two 3" Bakelite dials engraved as shown on the cut and one 2" dial also engraved. These dials must have knobs attached to them. Eight brass or copper binding posts, as are used with any radio receiving apparatus, are also required and one complete variable switch assembly with five contacts and their necessary nuts and washers. These would look best if they were nickel plated. The switch lever will swing within a radius of one inch. This switch is for the purpose of tapping the primary of the loose coupler. One of the contacts on the switch is left idle. Now, we will start on the panel and continue until the whole outfit is ready for instant use.

THE PANEL

Fig. 1 shows the exterior view, or front of the panel with the necessary articles mounted in their respective places, and the symbols indicating them.

Fig. 2 represents the interior view, showing the variometers and loose coupler mounted in their places, and the method of mounting them.

Fig. 3 shows a side view of the loose coupler with the method of mounting it three inches from the back of the panel, and, also, the method of placing the braces for the holding of the coil torm.

Fig. 4 shows both the internal and external hooking-up of the outfit. The builder following this hook-up should get very good results.

The symbols used in this receiver were adopted by five of the leading radio manufacturers of the country. The meaning of the symbols follows: Ant, antenna; Gnd, ground; Tel, telefone receivers; V. C., variable condenser P, plate; G, grid; Fx C, fixt condenser; Vmr, variometer; Var Sw, variable switch; LSCPR, loose coupler.

The panel may be bakelite, rubber, oak or boxwood and should be 12" long, 6" wide and from 1/8" to 3/8" thick. The measuring and drilling for the necessary holes should be done first, then the panel sandpapered and given two or three coats of varnish or paint. The panel described was oak and had three coats of black, glossy varnish. For the shafts on the variometers there should be 1/4" holes drilled; for the binding posts, 5/16" holes and for the switch contacts and switch lever 3/8" holes. After the drilling and painting are done the panel is ready to be engraved. The symbols should be neatly engraved on the front of the panel with a sharp-pointed slender tool and filled in with white putty or a similar substance. The panel is now ready for the mounting of the binding posts and switch assembly.

MAKING THE COILS

We will pass to the making of the different coils necessary for the successful operation of this outfit. The amateur must procure six winding forms in the following sizes: two, 4" in outside diameter and 2" long with a wall 1/8" thick; one form, 3" in outside diameter and 2" long with a wall 1/8" thick; two, 2 3/4" in outside diameter and 2" long with a wall 1/8" thick; one, 4" in outside diameter and 3 1/2" long with a wall 1/8" thick. All forms that are 4" in outside diameter are the different primaries for the different variometer assemblies, and the forms smaller in outside diameter are for the secondaries. Now take the two primaries that are 2" long and drill a hole in the center of them to allow a loose fit of a 1/4" shaft. This shaft is the means by which the secondary is revolved within the primary and the hole to be drilled in the secondary forms should be small enough to allow for a snug fit on the same size shaft. After this has been done, the four coil forms should be given a couple of coats of some good insulating compound. After they have dried they are ready for the wire to be wound upon them.

In this instance, the writer has used No. 24 D. C. C. magnet wire. On the primary form of variometer number one, the winding should start in 1/8" and continue over for 5/8"; then skip a space of 1/2" and continue winding until 1/8" from the end. (The writer thinks it advisable to have a little machine screw on both ends of each of the coils with suitable nuts and washers to which to attach the wire upon the starting and finishing of the winding. It also provides means of hooking the primary and secondary in series.) This will make about 42 turns in all on the primaries of variometer No. 1 and No. 2, making 21 turns to a section. Both primaries are wound alike. As the reader will note in Fig. 2, the coils are all wound in two sections; the space in the center is left to allow room for fastening the shaft securely. After being wound, the primaries should be given a coat of shellac, but care taken not to get too much on them as it would cause energy losses.

THE SECONDARIES

Now comes the making of the secondaries for variometers No. 1 and No. 2. These coil forms are 2 3/4" in outside diameter and 2" long. The winding on the coils starts 1/8" in and continues over for 3/4", leaving a 1/4" space. It again continues over 3/4", leaving 1/8" at the end. These coils are fastened at both ends by the same means as used on the primaries. The secondaries should also be shellacked.

THE LOOSE COUPLER

The next step is making the loose coupler. The primary is 4" in outside diameter and 3 1/2" long with a wall 1/8" thick. The primary should have a lip on it, as shown in Fig. 2, the purpose being a means of fastening the shaft. This coil form should be treated like the others. After it has dried, the winding will start on the lip end by attaching the wire upon the machine screw or post as was mentioned above, same as was done on the other coils. It should be wound 2" down with No. 24 D. C. C. magnet wire. In fact, all the coils are wound with this size wire and must also be wound in the same direction. After this coil has been wound, it is ready for the shellacking. On this coil four taps will be taken off. As the two inches of winding will equal 66 turns of wire, the taps will be taken off on the 16th, 33rd, 49th, and the 66th turns. A good way to take them off is to scrape the insulation back on the wire on the above numbered taps or turns and solder short pieces of No. 14 bare copper wire upon the scraped section, which will in turn connect to the different contacts on the panel.

We are now ready to make the secondary coil for the loose coupler. This coil form is 3" in outside diameter and 2" long with a wall 1/8" thick. It should have a hole drilled in the center of it to allow for the passing thru of a 1/4" snug-fitting shaft. This shaft is for the purpose of revolving the secondary coil within the primary coil and should be drilled for accordingly on the primary. The winding, to be fastened the same as in the case of the other coils, will continue over for 3/4", skip a space of 1/4" and continue for 3/4" more. This end will be fastened upon the post fitted for it. The secondary is now ready for its coat of shellac.

As was said above all the coils are wound with No. 24 D. C. C. magnet wire. The primaries on variometers one and two will have 42 turns upon each of them, which

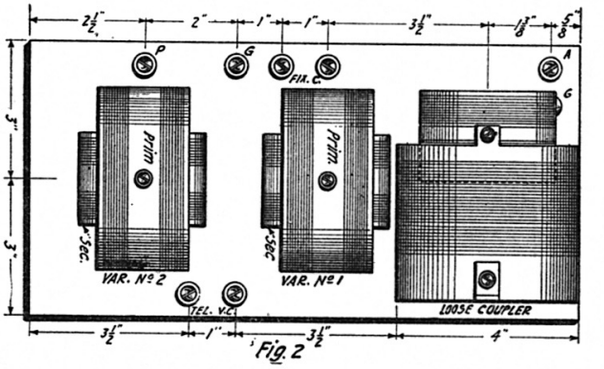


Fig. 2

Back View of the Panel on Which All Parts Are Constructed. Note That the Coupling Between the Variometers is Tighter Than in Some Similar Receivers.

*Manager Rumford Radio and Electrical Engineering Laboratories.

will be 21 turns per section, making a total of about 45 feet of wire to each primary, or 90 feet for the two. The two secondaries of variometers one and two will have 50 turns each, with 25 turns to a section. Each coil will take about 36 feet of wire or 72 feet for both. The loose coupler primary has 66 turns of wire, which would equal about 71 feet. The loose coupler secondary has 50 turns of wire, 25 turns to a section, which would equal about 40 feet. In all it requires 273 feet or close to one-half pound of the wire.

ASSEMBLYING THE PARTS

The outfit is now ready to be assembled. The binding posts and switch assembly have already been mounted. Now mount the primaries of variometers No. 1 and No. 2 by four little wood screws, two to a coil, which will screw in thru the coil form into the back of the panel, so as the shaft hole on the coil form will come in line with the hole in the panel. After that, get the necessary shafts, which should be threaded their whole length. Each one of these shafts should be 5" long and ¼" in diameter. One end of the shafts should be screwed into the knob on the dial and soldered so it won't work loose. It is then in turn pusht thru the panel from the front, thru the primary coil and nuts run on it so there will be a nut on the front and back of the secondary at each end, and on the inside and outside of the primary, which, when drawn up tight to the forms, will hold them securely. The above operation should be executed on both variometer assemblies. In hooking the primaries and secondaries in series, take pieces of No. 18 flexible lamp cord of sufficient length and connect the ends of it upon the screws or posts that are already provided in the coils.

In assembling the loose coupler: There is a rest made 8" long, 4" wide and ⅜" thick, which in turn is secured to the back of the panel by two wood screws, which go thru the panel from the front. This rest in turn will support the primary of the loose coupler. The primary is then mounted upon the rest and held there by four little braces, two of them angle form and the other two straight. These braces may be copper, brass or iron. The builder must bear in mind that between the back of the panel and the front of the primary coil form, there must be just three inches of space. This is absolutely essential or otherwise, when the secondary on variometer No. 1 is rotated, it would in turn rub against or strike the primary on the loose coupler. After this has been done the secondary of the loose coupler is mounted, the same as the secondaries on the two variometers. The wiring for the back of the panel is done with No. 14 stiff bare copper wire, which can be bent into the different shapes desired by the builder. Figure 3 shows the true method of mounting the primary of the loose coupler. The taps on the primary are hooked to their respective contacts on the panel. Figure 4 shows the method of hooking-up the outfit. Any trouble I have encountered in the working of this receiver, I have found to be due mostly to run down "B" batteries. There should be little or no trouble for the amateur in building this receiver as the drawings are self-explanatory.

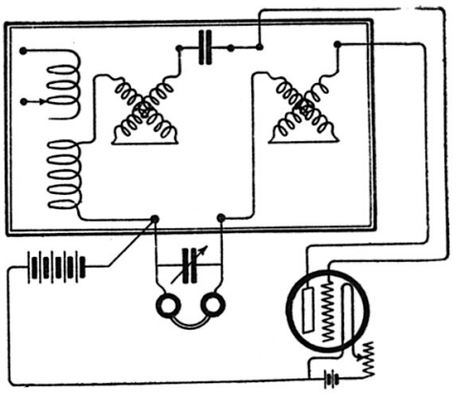


Fig. 4

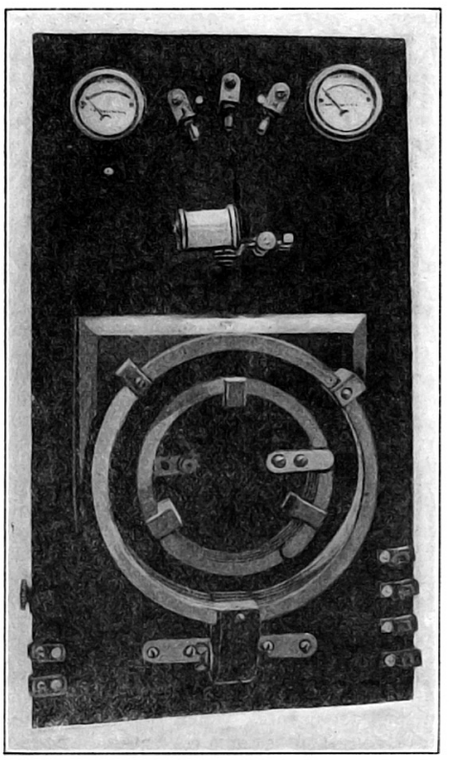
Complete Diagram of the Regenerative Set.

A Spark Coil Panel-Type Transmitter

By MARION W. TAYLOR

MANY amateurs who do not live in a city or large town are denied the pleasure of a transmitting station because of lack of power supply.

As I am in this class of amateurs, I have designed and constructed a panel-type spark transmitter shown in the photograph, which operates successfully on 24 watts. This transmitter can be constructed at a reasonable cost, and will satisfy the requirements of the average amateur for short distance work.



Front View of the Well-Designed Panel Transmitter. Note the Electro-Magnet and Electrodes of the New Gap.

The instruments used are as follows: 2" Superior spark coil, Murdock oscillation transformer, plate glass condenser, Columbia pocket volt meter and ammeter, Fahnestock clamps, and "Oscillation" spark gap.

The condenser is made of two glass plates 4" x 5" with tin foil sheets 3" x 4" between each plate. (As spark coils vary in strength, it is advisable that the reader build up his condenser until the right capacity is found.)

To build any size of condenser, photographic plates may be used and are to be recommended for they are generally free from flaws.

The film may be removed from the plates by immersing them in two solutions; the first one is made up in the proportion of ¼ ounce of sodium floride to 16 ounces of water. The second solution consists of ¼ ounce of sulphuric acid and 16 ounces of water.

After the plates have been placed in the first solution for a few minutes and then in the second solution the film comes off easily.

To arrange the tin foil sheets on the glass plates, the latter are coated with vaseline, then the armature put in position and rolled with a "squeegee." When the plates are all piled up they may be wound with tape and placed in a box which should preferably be boiled in paraffine for a few minutes.

To determine the capacity of this type of condensers the following formula may be used.

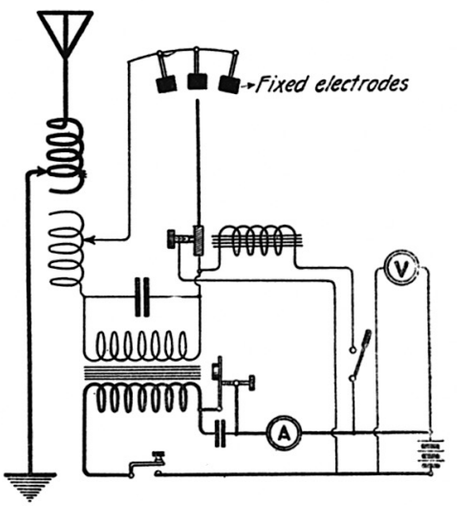
$$C = 0.0885\ K \frac{S}{r}$$

in which C is measured in micro-microfarad.
S is the surface area of one *armature* in square centimeters.
r is the thickness of dielectric in centimeters,
and K a constant which for the glass may be taken as 7.

The spark gap is a buzzer arrangement, with the exception that the vibrator is made from thin tin-covered sheet iron (the kind used to make tin cans) 2" long and ½" wide, to which is soldered a piece of spring steel 1½" long and ¼" wide. The electro-magnet is made by re-winding a 350 ohm ringer magnet with No. 28 D.C.C. wire. When in operation, the spring passes three equally spaced electrodes from which the sparks jump, producing the same effect as a rotary gap.

The panel is sheet Formica, 10" x 18" x ¼"; 3/16" holes are drilled. No. 2 are then punched out for the volt and ammeter; 3, for the gap electrodes; 3, for the electro-magnet, vibrator, and contact screw respectively; 1 and 2, for the primary leads; 11 and 12 are screw holes for mounting the oscillation transformer; 13 and 14 are for clamps to volt meter; 15 and 16, power input; 17 and 18, key; 19 and 20, screw holes for mounting panel to top of spark coil by means of brackets.

Under favorable conditions, this transmitter has an approximate range of twenty miles or more.



Hook-up of the Spark Coil Panel Transmitter. Note the Vibrating Spark Gap Used as a Substitute for the Rotary.

Using an Amplifier as a Detector of Long Waves

By H. K. DUNN

I WONDER how many amateurs know that long wireless waves may be received directly on their two-step amplifier, without the use of an extra detecting bulb and large inductances. The fact that this can be done should be of interest to those who have short wave receivers and amplifiers, but no long wave receivers. It should also be of interest to anyone who has experimented to any extent in radio, no matter what equipment he may have. Of course, nothing but the very longest waves can be so received, but it was very surprising to me, and will be I think to most of you, to learn that any signals at all could be received in this way. In the following paragraphs I will tell of my experience in discovering this phenomenon.

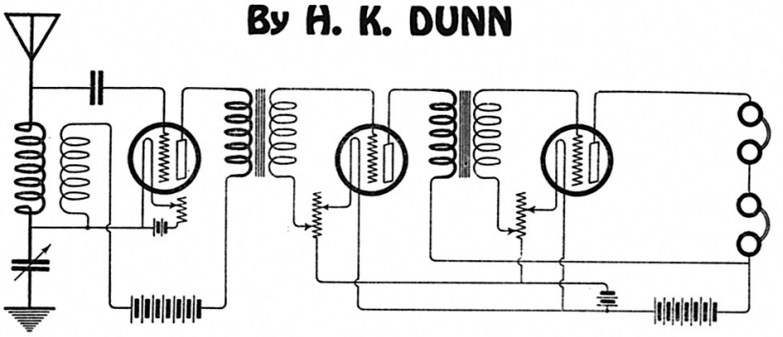


Fig. 1. Hook-up for Short Waves, Using Only One Variometer Designed by Mr. H. K. Dunn. Experiments With This Hook-up Led to the Discovery of the Possibility of Receiving Long Waves Without a V.T. Detector.

Mr. Myron Bunnell and I were working with the set at 8YR, Miami University, Oxford, Ohio. We were testing out the circuit of Fig. 1, where a regenerative set employing a single variometer is shown connected to a two-stage audio-frequency amplifier. I think it was the fact that *conductive coupling* was used that enabled us to make the discovery. After hooking up the circuit and throwing in the antenna switch we began to hear 200-meter stations by the dozen, a few of them using CW. We heard one, with a rather low pitch, which we did not seem to be able to tune out. This is unusual for CW, so I copied a little of what he was sending and soon found out it was WSO, coming in where 200 meters should come in. We then tried a number of changes, finally *turning the filament of the detector entirely out,* and still we could hear him.

From this it was very evident that our short wave set did not have much to do with the reception of these signals. We therefore removed it, connecting the aerial and ground directly to the amplifier thru a variable condenser, as in Fig. 2. We did not need to wait long for results, for by turning the variable we immediately tuned in WSO, NPL, and NSS. NSS was sending their evening press and we copied it without any difficulty. In fact, NSS was quite loud. The other two were not so loud and tuned in near the minimum of the variable, yet we could easily read both of them.

To complete the test I wanted to receive a foreign station. I waited until the next day at 5:00 P. M. (central time) when I knew LY (Bordeaux, France) would be on. At first I heard nothing at all. Then I happened to remember that the evening before we had been using two sets of fones in series. I plugged in the other fone and in they came, the same as before. Later I found that I could get them with only one fone by adjusting the filament temperatures. In any case the filament temperature seemed to need rather critical adjustment, that of the second tube especially being higher than I had been accustomed to burning it.

I tuned in LY at about the maximum of the variable. Then I tried taking out the condenser. This left me without a means of tuning, but it seemed to fit LY, altho their note was rather high pitched. Then I tried the circuit of Fig. 3 and got by far the best results yet, at least with such high wave-lengths as LY. By turning the condenser I could adjust their note to any desired pitch and got them *louder than I had*

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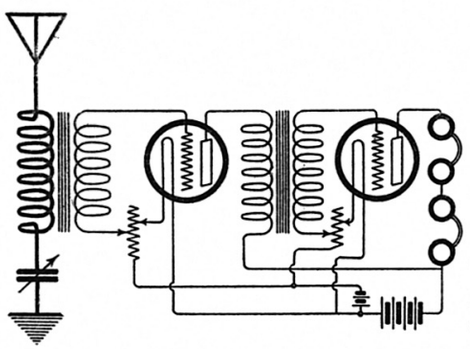


Fig. 2. Connecting the Aerial and Ground to the Primary of the Amplifying Transformer. Long Wave Stations Are Easily Pickt Up.

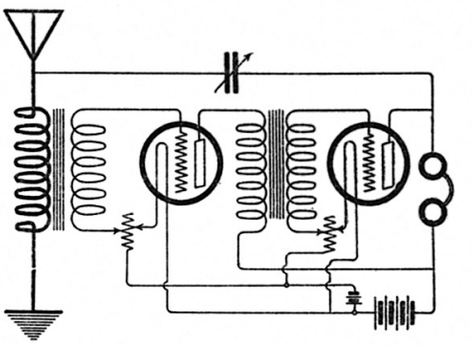


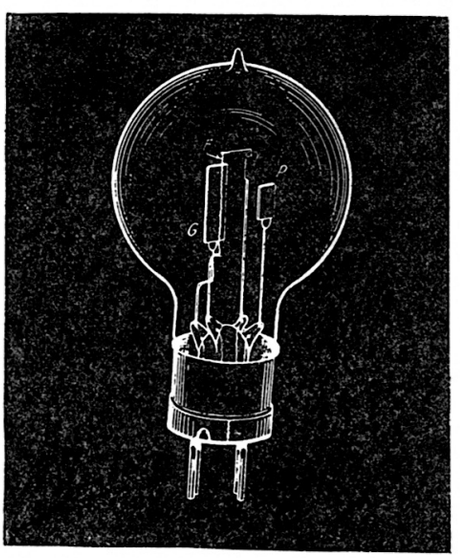
Fig. 3. This Diagram Shows an Improvement on the One of Fig. 2. The Variable Condenser Connected to the Aerial and Fones Makes a Reaction Effect in the Circuit.

A New Thermionic Vacuum Tube

By JOHN SCOTT-TAGGART

THE present writer evolved the type of vacuum tube described below, while carrying out some experiments on grid control during September, 1919. As is well known, the usual modern three-electrode valve consists of a filament surrounded by a cylindrical anode, a helical grid being placed between filament and anode. A positive potential on the grid will produce an increase in the anode current, while a negative potential will produce a decrease.

The writer's valve is shown in illustration. As will be seen, the form and relative positions of the electrodes are novel. The filament F is vertically arranged, the top support being a nickel-iron spring which keeps the filament taut when the latter is incandescent. The anode takes the form of a small metal plate placed preferably at a considerable distance from F. The control electrode, corresponding to the grid of an ordinary valve, takes the form of a metal plate G, preferably of larger dimensions than P and situated within a few millimetres of the filament F. The particular valve with which the curves, Fig. 2, were taken possesst the following dimensions: plate P 10 mm. by 10 mm. by 0.008 in. nickel sheet; plate G 22 mm. by 10 mm. by 0.008 in. nickel sheet; filament F crimped, 25 mm. by 2.3 mils, tungsten; distance F to P 9 mm.; distance F to G 2 mm.



The New Type of V.T. Fitted With a French Mounting. Note the Size of the Two Plates Acting as the Anode and Control Electrode.

A series of characteristic curves are shown in Fig. 2, and illustrate the effect of the control electrode potential on the anode current to P. It will be seen from the curves A, B, and C that the vacuum tube operates in a very similar manner to an ordinary three-electrode valve; that is to say, an increase of control potential causes an increase of anode current, while the reverse applies if the control potential is decreased. It will be noticed that the portions of the curves lying to the left of the ordinate thru zero potential on the control electrode are very regular and similar to those obtained with an ordinary valve. The bends at the lower ends of the curves are present, as usual. When, however, the control electrode is made positive, we notice that the curves commence to lean over rapidly to the right. This is attributable to the fact that G is now drawing to itself a considerable portion of the electrons emit-

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Fading of Signals

By S. R. Winters

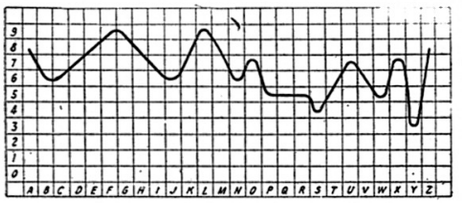


Fig. 1

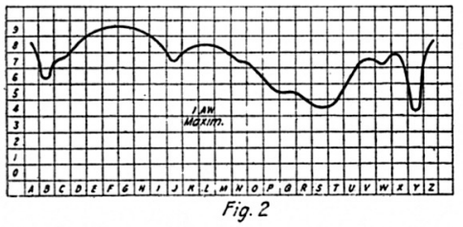


Fig. 2

Curve of the Same Transmission as Received by Two Operators. Note the Similar Shape of Both Curves.

THAT radio signal fading and swinging is a long distance phenomenon attributable to a varying reflection and refraction of waves, and that there is no intimate connection between weather conditions and radio transmission, are the outstanding conclusions of the most comprehensive series of tests relating to this subject ever conducted. The investigations were negotiated jointly by the Radio Communication Section of the National Bureau of Standards and the American Radio Relay League, the tests resolving themselves into two installments covering the months of July, August, and October of 1920.

While the utilitarian or man of affairs might inquire "What are you going to do about it?" as he would ask of any phenomenon, the absence of a remedy does not detract from the interesting details developed by this series of tests embracing the northeastern section of the United States. The theories unfolded as the experiments progresst, the anomalies discovered in respective sections of the country, the methods employed in conducting the tests, and the conclusions deduced, have engaging interest to radio operators everywhere. The 5,800 licensed amateur stations in the United States should peruse the results with peculiar interest. The original installment involved the active use of six sending and 45 receiving sets, while the second series employed six senders and 160 recorders. The northeastern territory was selected as the base of investigations by reason of the numerical strength of the amateur stations. Naturally, local conditions, the absence of interest, and the unsatisfactory service of scattering stations, served to eliminate about thirty recorders. The finish saw 130 recorders on the job.

Swinging or fading of signals is defined as a condition which interrupts the continuous transmission of a wireless message, the signals becoming so weak as to make receiving inaudible. To illustrate, the radio laboratory of the Bureau of Standards is listening to the station at Hartford, Conn., the call of the latter being received at normal intensity. The preamble of the message is recorded without any weakening of the signals, and as he begins to send the body of the message the signals become so strong that they can be heard all over the room. Then as the transmission of the text gets under way the signals become faint, unreadable for a group of words. Again they rise to distinctness and by the time the station signs off the signals are very loud. Obviously, fading contributes to the perplexities of radio communication and renders difficult and even impossible the copying of an unbroken message. The swinging of signals is so characteristic in amateur communication that the abbreviated warning "QSS"—signifying a fading of signals—is issued with quite the frequency that the indications of interruptions from "interference" and "atmospherics." Commercial wireless communication being done on long wave-lengths swinging is not so severe and rapid. The employment of short wave sets, with increasing popularity, by airplanes, in military operations, and in low-power ship communications, attaches significance to fading other than the difficulties experienced by amateurs.

The plan for the sweeping tests was suggested by S. Kruse, assistant electrical engineer of the Bureau of Standards, the idea receiving hearty approval at a conference of government officials and representatives from the American Radio Relay League. The sending stations selected included Hartford, Conn., Woodhaven, L. I., the Naval Aircraft Radio Laboratory at Anacostia, D. C., the station of the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., St. Mary's, Ohio, and St. Louis, Mo. "The amount of work involved in handling the 1,260 curves which were received can hardly be appreciated by anyone who has not attempted a job of this kind," emphasizes Mr. Kruse.

Brief descriptions of the sending stations are herewith presented: Station at Hartford, operated by H. P. Maxim, is situated directly to the east of a commanding hill toward which the antenna is directive. There is an absence of hills to the north and south and the country is level to the east for two miles after which it drops abruptly to the Connecticut River. The antenna is a bent fan of 17 wires spaced three feet apart at the high end and which is elevated 80 feet. All wires are continued thru the spreader at the low end to the anchor gap at the transmitting apparatus which is in the basement. The ground system is of a network of buried wires as well as wires to ground rods and to all the metal pipes in the building. The radiating system has a resistance of 5 ohms, and the sending set is of the 60-cycle non-synchronous rotary gap type. The normal antenna current is 5½ amperes. The station in Woodhaven, L. I., operated by C. J. Goetle, is not clustered with large buildings or trees. The

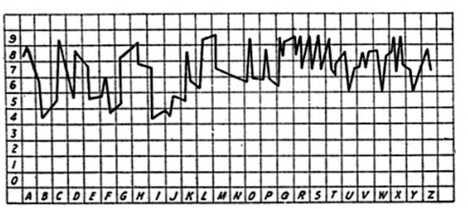


Fig 5

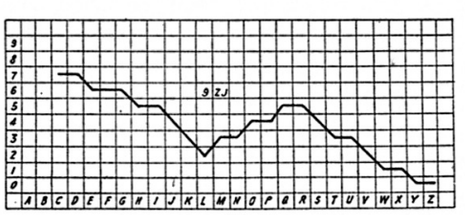


Fig 6

Top Curve Indicates the Way New England Stations Act Toward Each Other, While Curve in Fig. 6 Shows How New England Acts Toward Outside Stations.

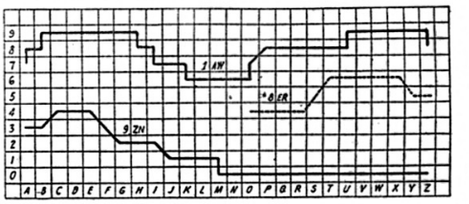


Fig.3

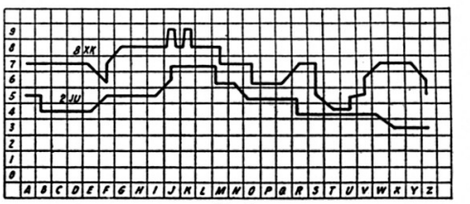


Fig.4

Curves Taken 150 Miles East of Cape May Aboard the U. S. S. Ohio, and Showing Fading of Signals at Sea.

antenna is a four-wire L, 50 feet high, 85 feet long, and 10 feet wide. The ground system consists of a lead to the water pipe and an eight-wire fan buried immediately under the antenna. The sending set employs a one kilowatt open-core transformer with a 30,000 volt secondary. It is picturesquely known among amateur operators as "the coffin," taking the designation from the resemblance of the box. The Naval Aircraft Radio Laboratory, under the guidance of Commander A. Hoyt Taylor, has a transmitting set which employs two electron tubes of the General Electric type P operating in parallel. The filament and plate circuits are fed by the same motor generator set, and the total input to the tubes is one kilowatt. The antenna is a multiple tuned, one 75 feet high and 235 feet long with three down-leads to the center of one of which the sending set is coupled. The station at Pittsburgh, operated by F. Conrad, of the Westinghouse Electric Company, has an antenna system consisting of a 6-wire L antenna 120 feet long, suspended 50 feet from the ground over a similar counterpoise elevated 12 feet. The station at Chicago, operated by R. H. G. Matthews, is too well known to permit of description, because of its war work. It is located within 30 feet of the sea wall of Lake Michigan. The station at St. Mary's, Ohio, operated by Mr. and Mrs. Charles Candler, has an antenna of a six-wire L, 55 feet high and 65 feet long. The grounding system consists of a group of 7-foot ground rods also connected to the water pipes and to a cistern. The station at St. Louis was the only one-half kilowatt unit employed in the network of sending stations. The antenna is a five-wire L, 55 feet high, 65 feet long, and 12 feet wide. The sending set is composed of an Acme one-half-kilowatt transformer, six Murdock condenser sections, of 0.0017 capacity each, connected in parallel and oil immersed to prevent brushing between leads.

Barring one, all of the recording stations identified with the radio signal fading tests employed a short wave regenerative receiving set. The recorders used a "soft" or gas tube as the detector and "hard" or high vacuum tubes for the amplifier. Likewise the recorders were in unison, with few exceptions, in using four or six wire L antennas about 60 feet high and equally as long, and made of copper wire No. 12, or 7-strand phosphor bronze.

(*Continued on page* 554)

Who's Who in Radio

No. 1 DR. LEE DE FOREST

DR. LEE DE FOREST, one of the pioneers in wireless telegraphy, whose genius created the Audion and the Audion Amplifier, an instrument that made possible transcontinental telefony and transoceanic radio telefony has during his entire lifetime been one of the most indefatigable and successful workers in this branch of electrical science. He has, in all, taken out over one hundred patents here and abroad on radio telegraphy and telefony, each one of which has materially aided in the world development of radio. His crowning achievement probably is the Audion Amplifier, which has accomplisht what the scientists of the world have vainly endeavored to do for a score of years.

Dr. De Forest is a native of Council Bluffs, Iowa, where he was born August 26, 1873. He was educated at the Mt. Hermon (Mass.) Boys' High School. He then entered the Sheffield Scientific School of Yale University for the electrical and mechanical engineering course, graduating in 1896. In 1899 he received from Yale University the degree of Ph.D. for work in physics and mathematics. For a time after leaving college he was attached to the Western Electric Company's Telefone Department in research work, when he began business for himself. From early youth he had determined to devote his energies to electricity and inventions, and he followed this inclination consistently by carefully educating himself for research along the lines selected for his life work.

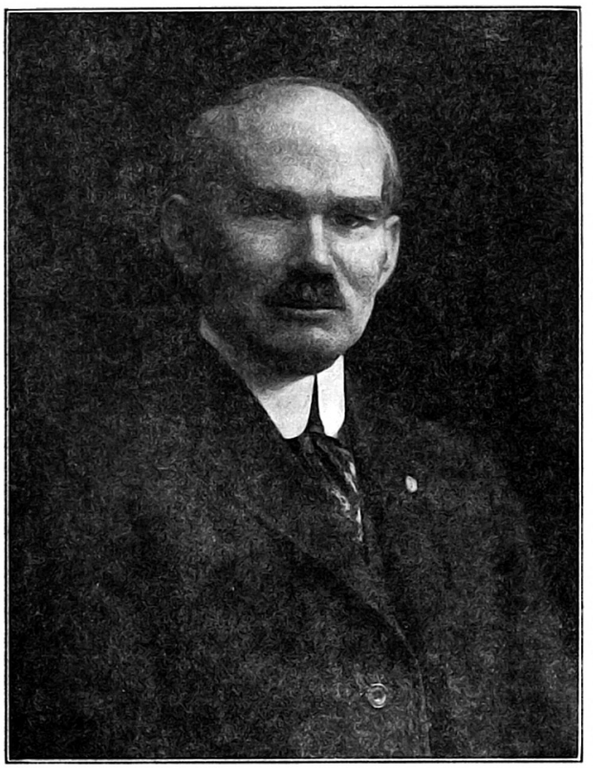
RADIO TELEGRAPH SYSTEM DEVELOPED.

His first important work was the development of the Radio Telegraph System, which bore his name from 1902 until 1910. In 1906 he began work on the Radio Telefone. For over a score of years telefone engineers had sought in vain a repeater or amplifying relay which should be at once extremely sensitive, free from delicate and frequent adjustments, and yet which would amplify every modulation or variation of the human voice without distortion. Without such a relay the telefone, at that time, was limited to a few hundred miles. The problem was a baffling one to the inventors and engineers in the telefone industry, and to stimulate action along this line of research an Eastern telefone company, in the late nineties, offered "one million dollars" for a successful telefone relay. This prize was never claimed nor awarded. The engineers still continued to work along the same lines, numberless patents were issued and untold thousands of dollars were spent on the problem. Meanwhile, thru all those years, the long distance telefone was halted, stopt effectively by that trifling little barrier—the repeater relay.

Prof. Pupin, of Columbia University, had discovered and patented the inductance coils which alone made it possible to speak intelligibly on overhead lines one thousand miles or over cable twenty miles in length. He sold his patents to the Bell Telefone Company many years ago, but the transcontinental telefone still remained a commercial impossibility. Theoretically, it was possible to build a line with very large copper conductors and plentifully spaced with Pupin coils, which would enable one, by using large electrical currents in the transmitter, to telefone across the continent: but, commercially, the staggering cost of such a line put this method absolutely out of consideration—it was impossible. So the telefone world waited hopefully for that yet unfound—the relay which could alone enable one to send, clear and audible, the infinitely delicate variations of the voice across North America.

AUDION AMPLIFIER EVOLVED.

At last that result was attained—not by telefone engineers, whose minds had for years spun in the old rut of receiver-microfone "Siamesed" together, but by De Forest, who beginning his pioneer experiments with wireless detectors, 'way back in 1902, discovered that a heated gas was "sensitive" to the weak "wireless" waves and could constitute a new detector for use in radio telegraphy.



Dr. Lee De Forest. Inventor of the Audion.

In 1903-4 Dr. De Forest made on this principle a genuine practical detector, possessing a sensitiveness far in excess of any hitherto known wireless receiver. Indefatigable in his efforts to further improve and apply his "Audion," this little incandescent lamp (which made *audiable* the action of the *"ions"*, or sub-atoms of the heated gas around the filament), Dr. De Forest discovered that these "ions" responded to telefonic currents as well as to those of the far higher frequencies used in wireless. He found that when this strange device, so utterly new to the telefone field, was properly connected in the line between a transmitter and a receiver, the Audion actually amplified the voice currents, giving a reproduction of perfect fidelity without a trace of lag or distortion, yet with an increase in volume, or intensity.

He patented the Audion Amplifier in 1907, but it was not until 1912 that he had brot it to such a state of perfection that he felt justified in bringing it to the attention of the engineering staff of the American Telefone and Telegraph Company. Three times this company has purchased patent rights under the Audion and other patents, paying nearly a half million dollars for them.

The Audion Amplifier proved to be the long-sought telefone repeater, or relay, of almost infinite sensitiveness and power, free of adjustment and distortion. Its use made possible, in 1915, the opening of the first transcontinental telefone service. Since then its introduction into long distance telefone service in this country and abroad has been almost universal.

By use of large oscillating Audions, wireless telefony from Washington to Honolulu has been achieved, and the detector is now used exclusively for long-distance signalling the world over—especially in the U. S. Navy Service. A work devoted to the progress of electrical science would be as incomplete without a description of Dr. De Forest's wonderful invention as it would be were the discoveries of Professors Moore and Bell left out; hence a few words about the Audion Amplifier.

DESCRIPTION OF AUDION AMPLIFIER.

This instrument consists of a small incandescent lamp bulb exhausted of air, containing, in addition to the usual filament, two thin plates of nickel about one-eighth of an inch from the filament on either side. Between the filament and the plates are two pieces of nickel wire bent grid-shaped. That is all. Can you imagine anything more simple, more utterly unlikely to operate as a repeater of telefone currents? Yet this little lamp was the one thing missing in the successful system of transcontinental and transoceanic communication. It links the Eastern with the Central, the Central with the Mountain, and that with the Pacific Coast.

In the Amplifier, the incoming current, to be repeated and amplified, is conducted to the "grid" wire. The outgoing line is connected, one terminal to the plates, the other to the filament. In this circuit is found a battery. A separate battery lights the filament to incandescence. The heated gas becomes then a conductor of the local current from the battery, which can pass from the cold plates to the hot filament. In other words, negatively charged "carriers," "ions," or "thermions," as they may be termed, speed in invisible streams of almost infinite tenuity from filament to plates passing in their migration thru the spaces between the wires of the "grids." Now, the slightest electrical potential, or charge, of electricity impresst upon these "grids" from the incoming telefonic currents deflects or retards some of these tiny carriers of negative electricity. This effect is always proportional to the cause, so that the current changes produced in the outgoing, or "plate", circuit are similar to those current changes or electrical charges, upon the "grid" wire which produced them. But the changes in current thus produced are many times in volume or intensity the changes in current which caused them. In other words, a unit electrical charge delivered upon the "grid" produces a deflection, or stoppage, of six to ten unit electrical charges passing from the filament to the plates. Hence the strange amplifying properties of the Audion.

THE BIRTH OF THE GRID.

The one most essential and completely novel element in the whole strange device

(*Continued on page* 560)

UNION COLLEGE RADIO CLUB

Perhaps a few of those who chance to read this article will recall having heard the spark of the old 2YU station, of pre-war days, with its 60-cycle rotary jazz, and its 240-cycle synchronous Marconi whine. The latter set was more pleasing to the ear, but severe in its treatment of condensers, the log book tells us; hence it was out of commission a very large part of the time. However, the club at that time was a pioneer organization at Union and a worthy predecessor.

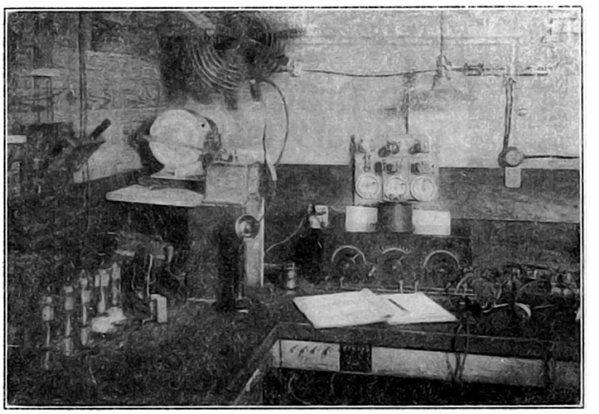
The present Radio Club was organized at the beginning of the college year along somewhat novel lines, inasmuch as it attempts to combine with the attractiveness of the undergraduate club, the effectiveness of the commercial corporation. Those who have had anything to do with the administration of an amateur radio organization realize the peculiar difficulties connected with such a concern. Suffice it to say that the system in use here aims to supply a job for every man; and there are forty-eight members in good standing who subscribe heartily to this policy.

The electrical laboratory of the college is used as a station, the operator's cabin adjoining the laboratory proper. A fan-type antenna is used, having a maximum height of 70 feet, and spread of 90 feet, with seven down leads, nearly vertical. The geography of the situation is such as to prohibit the use of a counterpoise; so the old ground system was again used, consisting of ten 3-inch iron pipes driven eight feet into the ground. The effective resistance of the entire system is about ten ohms at 300 meters.

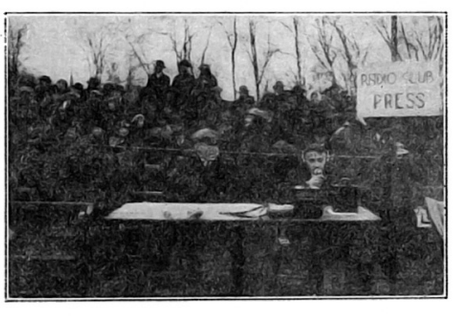
The regular transmitting set consists of a General Electric 60 cycle transformer, 110-13,200 volts, taking an input of 850 watts on full power; Dubilier condenser of .007 mfd. capacity, enclosed non-synchronous rotary gap and pancake type oscillation transformer. A six ampere scale thermo-couple ammeter is always in the antenna circuit and reads five amperes for normal operation. This set is tuned to a wavelength of 260 meters. There is also a 6 U-tube set, with voice and buzzer control, operating on 360 meters. Power is furnisht from a one kilowatt 1,000 volt generator, which gives an antenna current of 4 amperes. The Meissner oscillating circuit and "plate-modulation" are characteristic of this set. A third transmitter is being installed for the use of those who like to talk with local amateurs during the early hours of the evening. It will consist of a small spark coil and loose coupler. For regular receiving work the club uses an Adams-Morgan Paragon, with two steps of amplification and Baldwin fones.

The club is to have an appropriation of two hundred dollars from the college authorities for the purchase of a new sending set, enabling the organization to reach practically any of the larger cities in this country The addition of this large continuous wave set will put the Union club far ahead of most of the other college organizations in the matter of wireless equipment.

Needless to say, the activities of the club are limited to the school year, approximately Oct. 1 to June 1. There is an experienced operator on watch each evening from 10.30 to 12.30, Eastern Standard Time, to handle regular traffic. In addition, the club makes a special effort to transmit returns of local games and meets, both by radiofone and spark. Every Thursday evening a radiofone concert is sent out from 8 to 8.30, and from 9 to 9.30. A local dealer has taken sufficient interest in the scheme to supply a program of the latest records each week. The club has received a large amount of correspondence in regard to these concerts and feels that popular interest is sufficient to fully justify the effort.



This Very Efficient Station is Owned by the Union College Radio Club. On the Left is the 6-Tube C.W. Set Used for Undampt Wave Transmission or Radiofone Concerts.



This Field Station Installed by the Union College Radio Club at the Ball Game, Was Used to Send the Results to the Press.

SPRINGFIELD RADIO ASSOCIATION

Mr. F. Clifford Estey, president of the Essex County Radio Association, was entertained recently by the members of the Springfield Radio Association in an open meeting held in their club rooms at 19 Orleans St.

The subject of Mr. Estey's address was "County Radio Organizations." He spoke at length on the need of getting together and combining the amateurs into one large national body to escape commercialism.

In part he said: "The amateurs *must* get together to live. Big business is falling hard for radio telefony and when big business gets hold of a thing, it's pretty hard to make him let go."

Upon request Mr. Estey then gave a brief outline of the policy of the American Radio and Research Corporation, with which he is connected.

Instructor Creaser and President Cushing of the Connecticut Valley Radio Club of Springfield, then discusst the advisability of combining the two clubs of Springfield, but it was decided to wait some time before doing this. These talks were followed by the serving of light refreshments.

P. S.—Be prepared for the grand crash from the S. R. A.'s 1 K.W. soon.

YONKERS RADIO CLUB

The Yonkers Radio Club has the largest attendance of any radio club in Westchester County, having the good fortune to have in its membership such enthusiasts as Mr. Troube of DX fame, whom we no doubt all know well; Mr. Cloue 2HZ, the famous C.W. ham; also Mr. Hobe, another one of the C.W. bunch.

At one of the recent meetings of the club we had the good fortune to hear Major Armstrong deliver one of his famous lectures on the functioning of the Armstrong circuit. The meeting was largely attended.

One of the many topics of interest to all was recently thrashed out and a happy ending was the culmination of what at first appeared to be a sensitive subject; we all no doubt know that it was QRM.

The Junior members of the club were represented by Mr. J. S. Cornell, who let the older members know just exactly where they stood on the question of spark coil QRM. We all extend congratulations to Mr. Cornell. We think that many members of radio clubs are wont to disregard the junior members and thereby cause a great deal of hard feeling which should not be manifested in any organization, much less a radio one.

The club has the good fortune to have the use of the complete 200-watt C.W. transmitter of the Westchester Radio School, as also the complete rooms for code instruction of the members who are so interested. Call 2AYH.

Mr. Cloue, Mr. Remy and Mr. Troube have been appointed as the representatives of the Yonkers Radio Club to represent us at the Executive Radio Council, held for the purpose of reducing the QRM trouble in this immediate vicinity. Great improvements have been noticeable since this governing body has had the situation in hand and we all hope for better conditions to come.

SACRAMENTO RADIO CLUB

At a recent meeting of the Sacramento Radio Club, the following officers were elected to serve for a term of six months: Pres., Jack Irving; Vice-Pres., Lester Cate; Secretary, C. F. Mason; Treasurer, Edward Pitt; Radio Inspectors, Rad Coover and Will Yeaw.

Meetings are held on the second and fourth Thursdays of each month at the homes of the members. Plans are well under way now for permanent club rooms.

The membership at the present time is about thirty-five. We hope to make a notable addition to this number in the coming season.

The photograph at the bottom of this page is that of the 1-K.W. station, 6BAC, run by the club at the California State Fair held in this city last September.

Address all communications to the secretary, C. F. Mason, 2530 N St., Sacramento, Cal.

RADIO RESEARCH MERGES WITH RADIO CLUB OF THE BRONX

Owing to the lack of facilities and to the fact that the Radio Club of the Bronx needed members, the members of the Radio Research Club unanimously decided to merge with the former organization. This was done with the intention of forming one strong organization which would combine the advantages of both organizations for the advancement of amateur radio.

The Radio Club of the Bronx at present has thirty members and is able to accommodate a much larger membership. The meetings are held every Saturday night at 8 o'clock at 852 Manida St., Bronx. All those interested are cordially invited to attend.

As the Radio Research Club is now a thing of the past and will only be referred to in connection with the Radio Club of the Bronx, the members take this opportunity to thank those who have co-operated with them in managing the affairs of the R. R. C.

RADIO CLUB OF BROOKLYN

The Radio Club of Brooklyn, N. Y., announces that its meetings are now being held on the second and fourth Wednesdays of each month at its new headquarters, 2211 Bedford Ave.

The club has investigated traffic conditions in its vicinity and as a result is laying out local traffic lines thru Brooklyn connecting with 2RK thru the medium of a central traffic station, not yet appointed, for both incoming and outgoing traffic. Non-member stations are included as well as club stations, the routes being really an extension of the A.R.R.L. trunk lines, and all Brooklyn amateurs are asked to co-operate.

At the meeting held on January 12, the following officers were elected: C. Hild, president; H. Bierschenk, first vice-president; Chas. Porter, second vice-president; Elmer Baier, treasurer; C. Knudsen, sergeant-at-arms. The past officers were: C. Hild, acting chairman and first vice-president; Harold Knight, second vice-president; D. Langon, treasurer; L. Jacquet, secretary.

The R. C. B. expects to soon be in the magazine section of some Sunday papers. We want to inform our friends that a stag will be held at the

(*Continued on page* 560.)

This is the Station 6BAC Which Was Run at the California State Fair by the Sacramento Radio Club. Note the Complete and Well Planned Receiver.

Radio Digest

THEORY OF ANTENNA RADIATION.

A. PRESS.—After considering the previous investigations of antenna radiation the author attacks this problem, taking into account the sinusoidal distribution of current and voltage along the antenna. The vertical grounded antenna only is considered. A detailed mathematical investigation of radiation and field strengths at remote points follows. Formulas resembling the Eccles radiation formula and the Cohen dispersion and diffraction factor formula are obtained and interpreted.—*Proceedings Institute of Radio Engineers,* December, 1920.

MULTIPLEX RADIO TELEGRAPHY AND TELEFONY.

FRANCIS M. RYAN, J. R. TOLMIE and ROY O. BACH.—The authors classify the chief methods of multiplex radio communication. Duplex and quintuplex radio-telefony and radio-telegraphy over 5 miles (8 km.) at wave-lengths around 2,000 m. were experimentally accomplisht and are described.—*Proceedings Institute of Radio Engineers,* December, 1920.

SOME CHARACTERISTICS OF THE FREQUENCY DOUBLER AS APPLIED TO RADIO TRANSMISSION.

T. MINOHARA.—A general analysis is given of the theory of the ferromagnetic frequency doubler. The production of secondary circuit energy is secured either by the introduction of a sinusoidal secondary emf. or by the production of a sharply peaked "impulsive" secondary emf. In each case secondary resonance is employed to emphasize the desired double frequency. The sinusoidal-wave and impulsive-wave systems are oscillographically studied and compared for different types of secondary load. The impulsive system is recommended as having higher efficiency wherever the frequency is sufficiently low to avoid excessive iron-core losses with that form of wave.—*Proceedings Institute of Radio Engineers,* December, 1920.

THE NEW GENEVA WIRELESS STATION.

Many thousands of words are being sent out daily from the temporary Marconi Station at Geneva for the special use of journalists attending the Conference of the League of Nations, and over 10,000 words were handled on the 15th inst. within a few hours of the close of the first sitting of the Conference. Naturally, the Marconi Company is gratified with this excellent performance by a station which was completed only a few hours before the opening for commercial traffic. Rapid automatic transmission is being employed, the train of clear-cut signals, which cannot be understood aurally without special apparatus, being received at the British station at Witham, Essex, on rapidly revolving phonograph records. From Witham the signals are re-transmitted by Creed high-speed gear to London.

The station, which was erected in agreement with the Swiss Federal Government, is a 6 kw. continuous wave valve one, and the service commenced on the day the Conference opened. In addition to the primary service to the Witham station, communication has now been effected with Csepel (Hungary) Nauen (Germany), Centocelle (Italy) and Barcelona (Spain). The transmitting apparatus comprises one Marconi standard 6 kw. continuous wave valve telegraph set of the coupled circuit type, fitted with 6 "power" and 4 "rectifying" valves. The power is taken from the Geneva Supply Company and supplied to a 30 B.H.P. 500 volt two-phase motor, which drives by belt a 23 kw. 100 volt direct-current dynamo. An emergency power plant is provided, consisting of one 18 kw. 110 volts direct-current Austin oil-engine generator. One 6 kw. motor alternator is installed, taking supply from the 110-volt direct-current circuit, giving a single-phase supply at 500 volts 300 cycles. The voltage is raised to 7,500 by a step-up transformer, at which pressure it is fed to the valve transmitter panel. The signalling circuit comprises special high-speed keys operated by a Wheatstone transmitter, the tape for which is "punched" on a Gell keyboard type perforator. The aerial is of the umbrella cage type with six radial members, supported by a single lattice steel self-supporting tower 200 ft. high, each radial member being carried out to a 50 ft. pole at a distance of 300 ft. from the central tower. The earth system consists of the usual galvanized iron plates and earth wires buried in the ground. Five miles from the transmitting station is a separate receiving station erected so as to permit of duplex working. This station is provided with a special aerial constructed on the latest directional principles, and is connected to the transmitting station by landline.

The receiving station at Witham, near Chelmsford, is equipt with the latest type of directional aerial and, in addition to up-to-date valve receivers, is provided with dictafone apparatus for the reception of high-speed messages. For transmitting the necessary acknowledgments, service messages, etc., a 15 kw. valve transmitter at the Marconi Works, Chelmsford, is operated direct from the receiving station at Witham by landline connection. Witham is also in direct landline communication with the Marconi Company's London Office to which the messages are finally transmitted by high-speed automatic apparatus. Many thousands of words are daily handled by this service.

Radio Articles in the February Issue of Science and Invention

Grand Opera by Radio. *With special story of Madame Tetrazzini who sang by wireless telefone to U. S. sailors at sea.* By Nelly E. Gardner.

Sending Radio Weather Reports to Farmers.

New Loud Speaking Telefone Suitable for Use with Audion Amplifiers or Ordinary Telefone Circuits.

The Hall Jet Relay for Recording Radio Signals—*Complete Theory and Practical Details Described and Illustrated.* By Prof. Ralph D. Doner.

100 Words Per Minute by Radio Typewriter.

Stock Brokers Find Radio Useful.

PRESIDENT HARDING'S ADDRESS TO BE SENT BY RADIOFONE.

A Special Radiofone will transmit President Harding's inaugural address to every battleship and to halls in various cities where "inaugural parties" will be held. A committee of army and navy officers, headed by Rear Admiral W. H. G. Bullard, is named to make the arrangement.

In addition to the wireless service two huge megafones placed in the reviewing stand in front of the White House will be connected by wires to the amplifying device at the Capitol permitting crowds unable to be at the Capitol to hear the address.

FRANCE PROJECTS GIANT RADIO PLANT.

Louis Deschamps, Secretary of State for Posts and Telegraphs, laid on January 8 the cornerstone of what is designed to be the most powerful radio station in the world, capable of transmitting with two sending instruments 24,000 words hourly or receiving and deciphering 60,000 words hourly on five instruments.

The Lafayette Station, which is now the most powerful, has a maximum range of 15,000 miles, but experience has shown, according to the Ministry, that it cannot be depended upon for more than 6,000 miles regularly. The Sainte Assise Station when completed, in 1923, will, it is calculated, work easily and regularly with all stations in the world.

The striking physical features of the plant will be sixteen steel towers 800 feet high. A number of special telegraph wires will connect the station with the central telegraph offices.

AIRPLANE FLIGHT DIRECTED BY RADIO.

A French inventor named Detables has succeeded in getting financial support which will enable him to perfect an invention he has developed of an airplane which can be directed without a pilot over long distances by means of radio control much on the same principle as that employed for the direction of seagoing vessels by John Hays Hammond, Jr. In the early days of November, 1918, he says, he even succeeded in guiding an airplane at a height of 700 meters for a distance of nearly 125 miles. He is confident he can devise an apparatus for the control of bomb-dropping machinery and also that he can extend the scope of his airplane's flight area to at least 500 miles without a pilot.

RADIOTELEFONIA ESPANOLA

Radiotelegrafia con onda continua

By Rufino Gea y Sacasa

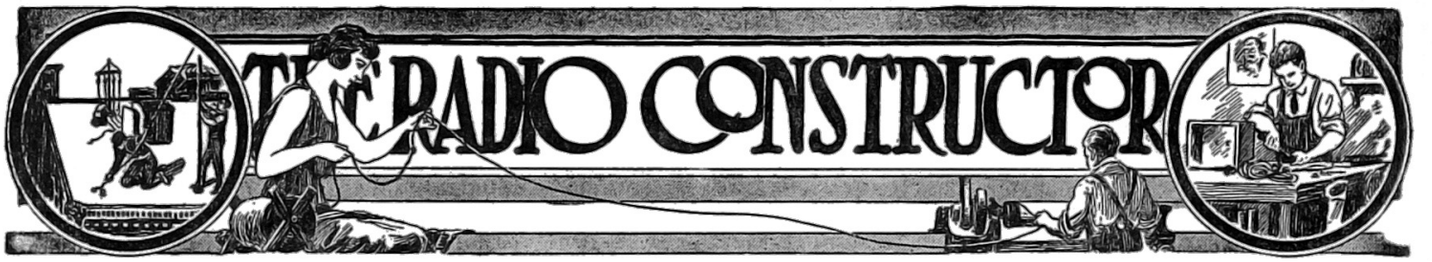
This little manual entitled "Spanish Radio Telefony and Undampt Waves' Radio," describes the functioning of the V. T. and gives many details on its application to radio telegraphy and telefony in Spain. Description and constructional details of the Spanish instruments are given in the various chapters, which are illustrated by good photographs and diagrams, making this little book a very complete manual of radio telefony.

Messrs. Rufino Gea and Sacasa, the authors, are well-known radio engineers in Europe and their work is to be classified among the best practical manuals on the subject.

Radiotelefonia española is publisht by the Publicaciones de el telegrafo español Madrid, and sold for four pesetas a copy.

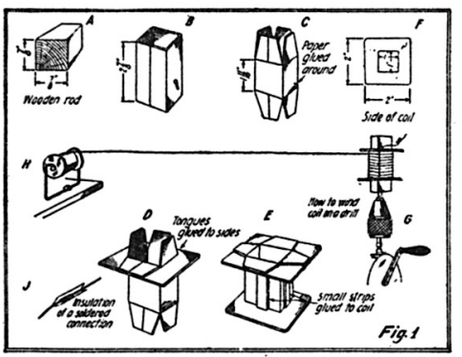
ROBINSON'S MANUAL OF RADIO TELEGRAPHY AND TELEFONY

We wish to inform our readers that the price of Robinson's Manual of Radio Telegraphy and Telefony, which was reviewed in the December issue of RADIO NEWS, has been changed to $2.50 a copy.



Practical Construction of an Amplifying Transformer

By ROBERT E. LACAULT



Constructional Details of the Form on Which the Transformer is Wound. For Winding, a Drill May Be Used as Shown in G.

MANY amateurs dream of a sensitive amplifier and take a great interest in looking at the display of apparatus exposed in the various radio stores. The chief trouble with these sensitive receivers is the price.

Amateurs, here is a means to fight the high cost of radio apparatus. You, can build yourself a two or three stage amplifier without spending a great deal of money. Building your amplifier yourself, you will have a sensitive apparatus fitted with many steps of amplification for the same price as one you buy ready made, having but one step.

Many diagrams of audio frequency amplifiers have been publisht in this magazine, and the type of transformers described in this article may be used in these circuits. The construction of this audio frequency transformer does not present great difficulties and all amateurs having a little hand practice will turn this out successfully.

At first secure about 3300 yards of No. 44 silk cord covered wire and some sheet iron for the iron core. The core is made of 56 strips $\frac{13}{16}$" wide, 9½" long and about 0.014" thick (No. 29). They are then cut to the correct size with a snip. For shown in Fig. 3 they are not all of the same length. The eight strips in the center of the core are 9½" long, the next eight strips are 8½" long, the following 7½" long and those placed outside are only 6½" long. This iron core is placed in the center of the coil after the latter is wound.

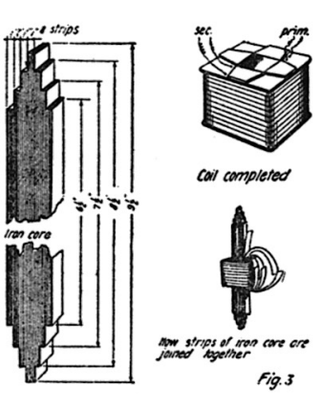
The coil is made of cardboard 1/24" thick, to make it of the proper size it is necessary to make it on a form. This form is only a wooden rod 3" long and of a square section ⅞", with a file the edges are smoothed, this, to allow the coil to be taken easily out of the rod when finisht and to avoid sharp edges. See Fig. 1-A. This form being held at one end in a jaw, a piece of cardboard 2-4/16" wide is wound around, only one turn is made and the two ends joined on a face of the square form. See Fig. 1-B.C. To hold it in place a strip of paper of the same width is glued around. After this is dried the corners of this square cardboard form are cut as shown in Fig. 1-C.

The two sides of the coil are made of the same kind of cardboard as in Fig. 1-F. They consist of two squares of two inches with a one inch square hole cut in the center, then introduced onto the center part and the four tongues at each end are bent and glued on the two sides which must be parallel and distant of 1-$\frac{11}{16}$" as in Fig. 1-D.

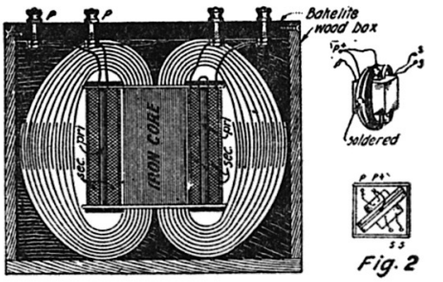
To obtain this easily and in order to give a better shape to the coil for the winding, four little strips of the same cardboard ⅜" large and 1-$\frac{11}{16}$" long are stuck on the four faces. See Fig. 1-E. When this coil is completed and dried it must be coated with shellac to give good insulation.

In order to give the proper shape to the center of the coil, one layer of very thin silk ribbon about ⅜" wide is wound around, and then another coat of light shellac varnish applied over it. The winding will be preferably made on a lathe but the amateurs who do not possess this machine may wind the transformer easily, using a Goodell drill or a phonograph motor run at low speed. A special mounting must be made for the spool of wire which should be placed far enough from the lathe or winding machine (4 or 5 yards), the wire being very small cannot support a heavy strain and this length of wire reduces it. A simple bearing supporting the spool, can be made of straight wire fixt in the center, and supported by another wire bent in the form of a fork as shown in H, of Fig. 1, and fitted with an eye at the end of each arm.

During the operation of winding, if the wire breaks a good soldered connection must be made and placed in a little folded piece of silk ribbon, as in Fig. 1-J. The connection to the wire running in or out of the coil will be also soldered and insulated in the same manner. These connections will preferably be made of a piece of "Litz" wire entering the coil by little holes bored in the sides. A length of about 4" is kept outside and two turns are made around the core to fix it firmly. The No. 44 wire is then soldered to it and the winding begins.



Details of the Iron Core, Made of No. 29 Laminated Steel.



The Transformer When Completed is Enclosed in a Box and the Space Around it Filled With Paraffine. Note the Method of Winding the Primary Between Two Parts of the Secondary.

As will be noticed, in Fig. 2, the primary is sandwiched between two parts of the secondary. After the first half of the secondary winding consisting of 7,500 turns is made, a connection is taken out, then two layers of the same silk ribbon already used is wound over, and finally the primary wound the same way. In order to recognize the wires coming out from the coil some small labels will be fixt at their ends. After the 4,000 turns of the primary are wound with the same No. 44 wire, two other layers of silk ribbon are placed on top as a covering insulation and then the other 7,500 turns of the second half of the secondary are wound over this. When this is finisht the same silk ribbon is applied to cover the winding and the finisht coil is then shellacked.

When the coil is dried the iron core is then introduced in the center hole and the iron strips bent as shown in Fig. 3. Beginning with the outside ones, each end of a strip is put in contact with the other, thus closing the magnetic circuit on each side of the coil. To keep all the strips in place the last one to be bent over is soldered. When both sides are fixt in this manner, a few turns of copper wire are wound over the iron cores, and also soldered on each side where the iron strips are themselves soldered.

The last operation consists of enclosing the transformer in a little box fitted with a hard rubber or bakelite top in which four binding posts are inserted. The transformer being placed in the box and the connections taken out, the box is then filled with *boiling* paraffine which is poured *slowly* into the box with a spoon. The four binding posts in the top of the box are used for the primary and secondary circuits. The copper wire wound around the iron core is also *soldered* to one binding post of the primary which must be markt accordingly and which is connected to the positive (+) of the B battery. This avoids hauling or detrimental noises.

Tho this may seem complicated to the amateurs, it is in fact simple and worth the work and time devoted to the construction of this piece of apparatus. Besides the saving of many dollars it will be worth more in the eyes of the amateur who will have had the satisfaction gained by personal accomplishment.

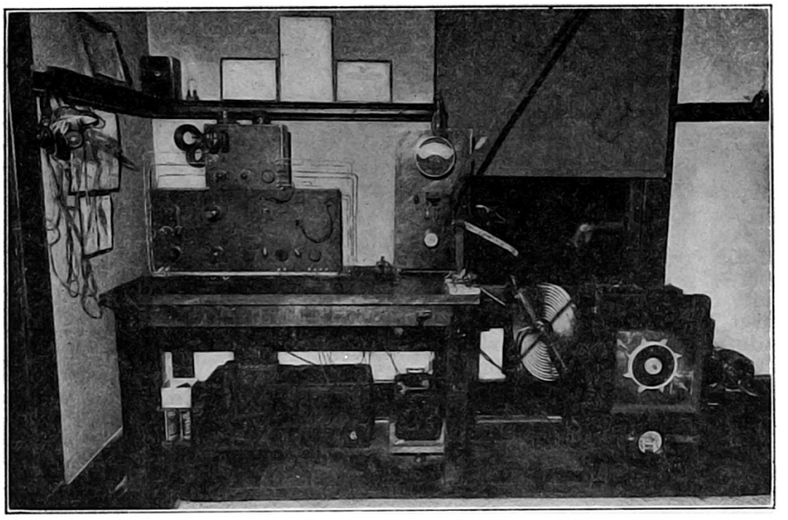
THIS Department is open to all readers. It matters not whether subscribers or not. All photos are judged for best arrangement and efficiency of the apparatus, neatness of connections and general appearance. In order to increase the interest in this department, we make it a rule not to publish photographs of stations unaccompanied by a picture of the owner.

We prefer dark photos to light ones. The prize winning pictures must be on prints not smaller than 5 x 7". We cannot reproduce pictures smaller than 3½ x 3½". All pictures must bear name and address written in ink on the back. A letter of not less than 100 words giving full description of the station, aerial equipment, etc., must accompany the pictures.

PRIZES: One first monthly prize of $5.00. All other pictures publisht will be paid for at the rate of $2.00.

Louis Falconi's Station

THIS MONTH'S PRIZE WINNER



Here is a very good and efficient "ham" station. We extend our compliments to the owner and wish to see more like this one.

BELOW is a description of Radio 5ZA in Roswell, N. M.:

The receiving equipment consists of a long wave receiver using honeycomb coils and a short wave receiver of the variometer regenerative type. The upper small cabinet contains the long wave units and the lower larger cabinet houses the short wave units and a two-step amplifier. The amplifier is so connected that it can be used either in connection with the long wave set or with short wave set by the throw of a switch shown on panel of large cabinet. Plug and jack system is used for plugging any step of the amplifier and also for plugging in fones.

The transmitter is at the right of the photo and standing on the floor.

It is built as a complete unit. The rotary gap and quenched gap may be seen mounted on the front panel, the quenched gap just appearing over the panel since it is mounted on the back of the panel. The rotary gap is housed by a box with glass front. The small motor on the right of the sending unit runs the rotary. The OT is plainly visible and is of the ribbon type, the secondary being hinged. The condenser is immediately behind the front panel and is made of plate glass and copper sheet immersed in oil. The transformer rests on the condenser. The frame of the transmitter unit is made of angle-iron and the panel is bolted to it. All wiring is lead covered. The radiation meter is below the rotary gap.

On the table, the switchboard controls the power circuit. The large meter indicates the amperes in the transformer primary. The change-over switch is just in front of switchboard.

Under the table may be seen the A battery and B battery box. A vibrating rectifier just above storage battery under the table, charges the A battery.

A wavemeter on the shelf on the wall completes the equipment.

The aerial is composed of four wires 80 ft. long on poles 55 and 65 ft. high.

5ZA is one of the relay stations between the east and west. Many messages are sent from one coast to the other. Signals from 5ZA have been reported from Fort Pierce, Fla., Portland, Ore., Princeton College, N. J., Billings, Mont., and many other far distant points.

The radiofone at Catalina and Long Beach, Cal, is heard all over the room on good nights.

LOUIS FALCONI, Radio 5ZA,
Box 421, Roswell, N. M.

Station of Ralph O. Martin

THE station of Ralph O. Martin, Kenosha, Wis., is in a one-story frame building, located at the east end of the antenna. The antenna is an "L" 75 ft. long and 50 ft. high, with four wires.

The receiver needs no detail as it is of the Chicago Radio Laboratory, a "Paragon" and "Amplifigon" combination, which works very fine. The receivers are a one-time pair of German fones.

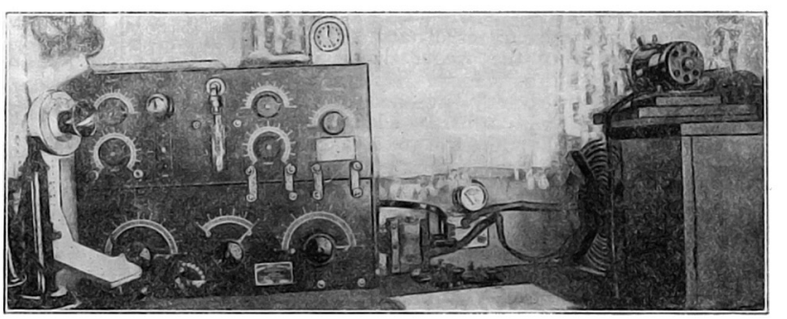
The transmitter consists of an "Acme" 1-k.w., and a special gap designed by 9JT, altho the picture shows one of "Signal" make. The condenser is a Thordarson, while the OT is homemade. The radiation is seven amps on high power and four on low. The record transmission is to 3GO, while 9GP has been heard at 6ZH, Richfield, Utah, who reported sigs QSA. The ground is of the counterpoise type, rods also being buried in the ground.

Up to this writing 182 messages have been handled since Sept. 1st, 9GP being on the "Lake Shore Route" in the Central District.

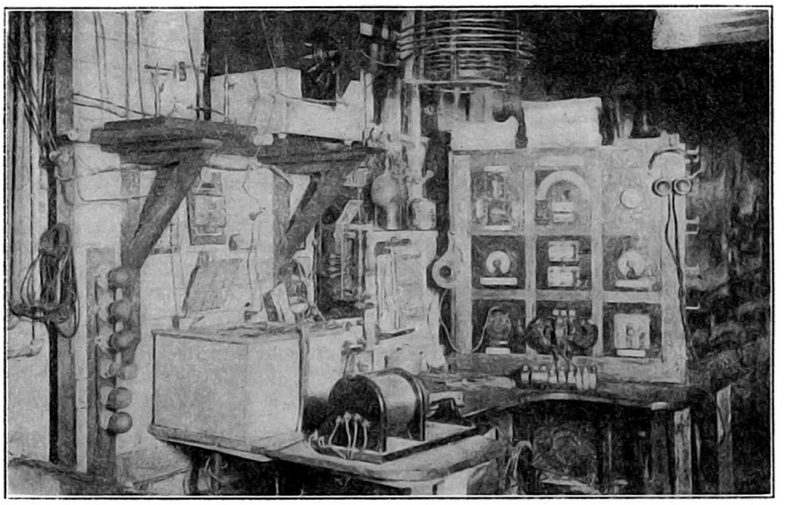
I find RADIO NEWS very interesting and instructive and lay no small part of 9GP's increasing success to its excellent qualities.

RALPH O. MARTIN, 9GP,
818 Sheridan Road, Kenosha, Wis.

Another well planned 1-K.W. station. No wonder he gets them with this kind of a receiver!



Jos. L. Telmosse's Station



This one is a real experimental station, including a small radiofone and a good looking homemade panel receiving set.

HERE is a photo of my homemade reception and transmission set. The system is honeycomb coils of four different sizes, 50—110—350—650 turns each, tickler circuit. I hear all sorts of wave-lengths from 100 to 20,000 meters dampt and undampt waves. I have two amplifiers and also telefone transmission which I use with one of my valves, taking 4 watts, and go as far as five miles, without switching anything on my set, either to speak or receive.

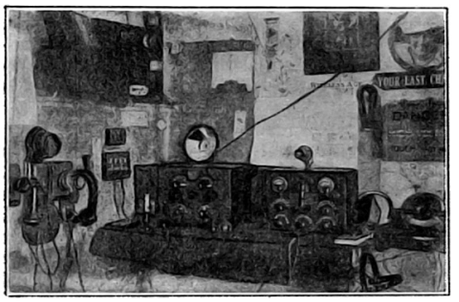
My telegraph transmission is also a homemade transformer of about 750 watts, 60 cycles, 110 volts, variable condenser submerged in oil and helix.

A special rotary switch enables me to connect and disconnect all in one movement, the reception and transmission set, also to keep them both disconnected together.

I have caught stations from San Diego, Cal., to Nauen, Germany. I often receive gramophone music, very clear and strong, played by a station at Green Harbor. They work at about 350 meter wave-length. When using my amplifiers I cannot keep my fone set on my head for some stations, signals being too loud. I have about 800 feet wire for aerial antennae, 75 ft. from the ground and about 400 feet above mean sea level.

Jos. L. TELMOSSE,
Shawinigan Falls, Que., Canada.

Station of W. L. Stannard



Leon Doesn't Trouble the Ether for He Has No Sending Set, Only a Very Sensitive Receiver.

HERE is a photograph of my station, which as yet, is for receiving only. The two large cabinets are the Mignon RLC5 and Audion panel ET1. I have added a one-step amplifier, as you will note, above the audion panel. The panel on the extreme left is for controlling either a 23 or 43 plate Illinois condenser into series or shunt with aerial and ground.

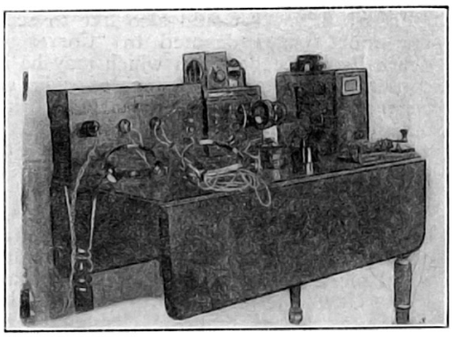
Western Electric and Holtzer Cabot fones are used. The intercommunication fones are used to advantage in the house. Over the audion panel is a wiring diagram of the room. An A.C. arc can be seen on the extreme right with its reflector. This is used successfully for searchlight communication.

Dash lamps are used to illuminate the set at night and are supplied with current from a step-down transformer. The current is regulated by the rheostat shown on the switchboard on the wall.

Press is received extremely clear every day and the majority of stations on the coast are audibly received. No difficulty is encountered in tuning any one in or out. Among other stations, NAT, NAJ, NAR are clearly heard, also numerous ship stations.

W. LEON STANNARD,
379 Allen St., Springfield, Mass.

Station of Cyril T. Atkinson



Boy, What Do You Think of This 10-Watt Station? It is the Maximum Power They Are Allowed Over There and Yet They Do Some Good Work.

STATION OF CYRIL T. ATKINSON.

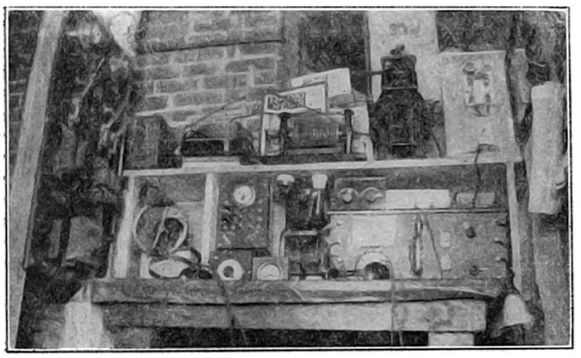
HAVING been a subscriber to RADIO NEWS for the past two years and as I always enjoy reading about the other stations, I am sending you a small photo of my radio set, feeling that perhaps it will be of interest, showing as it does a typical English station with its low power transmitting set.

The case at the left contains the valves, three in number, together with their condensers, transformers, etc. The first valve is arranged as a detector, together with two low frequency magnifiers. Next comes the tuner consisting of a small tubular coil for waves from 150 to 1,500 meters, and the well-known honeycomb set for all other waves. At the right is the transmitter consisting of a tuned spark set. The coil just absorbs the allowed 10 watts and radiates 180 meter waves. Since taking the photo inductive coupling has been applied.

My receiving results are good as on the small aerial I have a single wire inverted "L" 35′ flat top, 45′ lead in. I get all the British and European stations of fair size and one or two of the very high powered American ones.

CYRIL T. ATKINSON, 2CZ,
17 Beaumont Road, Leicester, Eng.

Station of Emery D. Austin



Yours is a Good One, Em, and We Are Pleased to See That You Used a Quenched Gap. Tell the Others to Do the Same.

THE photo is the station 1TK. The receiving cabinet on the right is a homemade one, containing the following apparata: Resco tuner, three variable condensers, audiotron and controls, 3,000-ohm receivers Murdock. This will tune to around 3,400 meters.

The transmitting set consists of a 1-K.W. Thordarson 20,000 volts transformer, pancake helix, home-made condenser, Amrad Quenched, and home-made aerotone rotary, with necessary switches to change from rotary to quenched. The antenna is 70 feet high and 70 feet long and is composed of three wires.

The wave-meter belongs to our club; switch board consists of amp. meter, volt meter, one automatic switch and necessary fuses.

With this set altho I do not use any amplifier I hear many distant stations and some of them come in very loud. Among there are NAA, NAH, WBF and many others; also many amateurs. I belong to the American Radio Relay League, Radio Relay League of America, and the Central Maine Radio Club. Am assistant traffic manager of the American Radio Relay League and secretary of the Central Maine Radio Club.

EMERY D. AUSTIN,
Waterville, Me.

CORRESPONDENCE FROM READERS

SOME REAL SUGGESTIONS

Editor RADIO NEWS:

I note the letter in the December issue of the RADIO NEWS written by Mr. F. L. Woolsey and wish to express my opinion of the same. There are today about eight magazines on the market that print literature and editorials exclusively on the various branches of radio science in addition to about four other scientific publications which may or may not refer to radio articles. Out of the eight radio magazines, only two can be classed as high grade amateur periodicals, these two being RADIO NEWS and "Q. S. T.," and of these two I believe there is no doubt in the majority of amateurs' minds that RADIO NEWS is far superior in every respect. I feel that a bi-monthly publication would be too often, for the reason that a number of the articles printed require time and thot in reading. I would like to see more of these articles printed and feel that in addition to being an asset to the radio world in general, they would increase the sterling qualities of RADIO NEWS.

Now may I make a few suggestions which I believe would be beneficial to RADIO NEWS and also of interest to my fellow readers? Occasionally some condensed article is printed from the abstracts of the I. of R. E. proceedings. Why not have more of this? I would also like to see a few more pages devoted to "Correspondence From Readers," in which may be incorporated written discussions of radio experimenting with conclusions as worked out by the readers of RADIO NEWS. I would also like to see more "Digest" articles, particularly on what the Bureau of Standards is developing.

If you think well of these suggestions, I believe my fellow readers would be interested in reading them. Do not misunderstand me in thinking I am trying to make RADIO NEWS too technical for the radio beginner, as I feel that the elementary articles should still be continued for the benefit of the amateur starting into the game.

What do other readers think of these suggestions?

E. E. FREY, 2AJK,
50 Renner Ave., Newark, N. J.

(*Righto, 2AJK! We want those amateur letters. You know how we feel about that "human interest" stuff. But of all the gosh-darn lazy birds, you amateurs take the cake. You like to sit in your ether-attic puffing away at your pipe while you read* RADIO NEWS—*YOUR magazine, YOURS, but it's more difficult to get a letter out of you case-hardened ether-slingers than to coax a signal out of a burnt-out spark plug. You never seem to get the idea into your Q.R.M.—ether-soaked—V.T.'s—otherwise known as your skulls—that* RADIO NEWS *was created for the radio fraternity, that it's YOUR stamping ground, that Amateur Radio can only live and be a great institution if all of us work and pull together. That means we must exchange ideas, tell the other fellow what we are doing and how. There is altogether too much false secrecy, too much bashfulness, too much hiding "one's-own-light" among present day amateurs.*

Come out in the light, fellows, open up the rotary and give us a few real-to-goodness flashes. Who'll be the first to get off that letter to-night? —*Editor.*)

WHY THE HIGH COST OF V. T.'S?

Editor RADIO NEWS:

Concerning the article in the latest issue of RADIO NEWS by Mr. Mason on the high cost of V.T. tubes, I wish to say that the situation is indeed deplorable. Many amateurs are forced to rely exclusively upon the old crystal detector, simply because their financial standing will not permit their investing in a V.T.

Mr. Mason, in my opinion, best illustrates the absurdity of such an exorbitant profit as is realized on a tube: Take for instance the bulb and dissemble it. First you have a vacuum bulb which can be constructed at a cost not exceeding ten cents; second you have a filament which costs about, say, another ten cents. Third and last your grid or plate enters, costing about five cents; now taking all together your complete outlay amounts to twenty-five cents. Compare the cost with the retail price and the profit shows twenty-eight hundred per cent!

It is not the retail dealers who extort the profits on this article. It is the manufacturer. Of course the money expended in the settlement of patent troubles would naturally increase the cost a little but still not enough to cause such a profit.

There are the blessings of a million amateurs awaiting man or boy who successfully solves the problem of placing a cheaper *yet equally efficient* vacuum tube on the market.

S. M. BODDINGTON,
Scranton, Pa.

QUESTIONS VERNON'S STATEMENTS

Editor RADIO NEWS:

In your December issue you publisht an article on the Radio Compass Stations in San Francisco Bay, contributed by Phil Vernon. The article was good in itself, but it contained some misleading statements.

As a commercial operator, I have made frequent use of the R. C. stations located up and down the Atlantic Coast, also those in France and England, and I would like to ask Mr. Vernon some questions.

He says in his article: "Vessels have also been instructed to use maximum power, broad coupling and low decrement, . . . etc." I would be interested in knowing the source of these "instructions."

Are we to infer from the above statement that irrespective of distance, we must open up on full power (in my case 2-k.w.) whether we are five or fifty miles from the R.C. stations giving bearings?

In entering the Virginia Capes in thick weather, I could easily interfere with NSD giving bearings to another ship if I worked on high power with NCZ2.

Does not the law of "minimum power necessary for communication" apply equally to a QTE as to commercial traffic? In actual practice, I have been told to QRP more often than to QRO—and I very seldom use more than 1-k.w. for an R.C. bearing unless some distance off shore, and conditions are bad at the moment. Personally I do my testing with the same amount of power and the same degree of coupling as I use for calling the station with. I am of the opinion that the majority of operators do the same, tho I may be wrong and would like to be informed.

THOMAS B. CRONE,
Portland, Me.

WANTS RADIO NEWS A BI-MONTHLY

Editor RADIO NEWS:

Hurray!!! I second Mr. F. L. Woolsey's motion. Let's have the RADIO NEWS a bi-monthly. He is right; one nearly goes crazy waiting for the next issue. Even if we have to pay 50c. a copy, it's worth it!

You'll hear from me again later. You ought to see the nifty combination two-step amplifier and C.W. transmission cabinet I'm going to send in soon. But seriously—please consider that bi-monthly idea, and let's hear the verdict in an article in the RADIO NEWS.

RUSSELL MORRIS,
Madison, Wis.

(*A bi-monthly at present is an impossibility, mainly for economical conditions prevailing just now. Due to tremendous paper prices, nearly every publisher loses money at present, we included. Till conditions change, fellows, we're mighty glad to come out once a month, and that's tough sledding!—Editor.*)

ABOUT RELAY WORK

Editor RADIO NEWS:

Read your comment on my letter in the January number.

It was not my intention to start a scrap of any kind, but when I wrote the letter, I was feeling quite "hot under the collar" after reading an article, "Let's Go," on page 288 of the November number. In this article, just about the middle of the center column, the writer says: "We waste too much time, *all of us* 'QST'ing' and 'CQ'ing' when, etc.—when all that 'we' amateurs say to each other in the course of a year amounts to just about nothing. Nine million: 'How is my spark's.'" The writer of that article cannot amateur himself. "Amounts to just about nothing," indeed! Well, it just amounts to this; one of the United States radio relaying associations found it necessary to refuse to accept messages for transmission on their routes between the large cities, unless they contained something of value, as they handled so many messages that serious delay might occur if too many were handled. I listen in nearly every night myself, and nearly every message that I hear is something like "Leaving 6:30 P. M. tonight" or "Write immediately." I have a sneaking suspicion that contents like those that I have just mentioned amount to "just something," if not a good deal more, and this variety of message predominates over the "greetings" class, which doesn't amount to a great deal. If your associates did not find that article with the spectroheliograph, they had better send the said spectroheliograph back to the blacksmith shop for repairs, as it was so QSA (the article) up here that my bulb slipt on its charcoalistic curve and skidded into the V.C. and made the grid leak and I couldn't finish reading it until I borrowed the mop and wiped the leakage up and then went down into the cellar, 19 stories below, where I could hear it good without any amplification. I'll say so. It made me see vermilion (pardon me, I meant red) and visions of sledge hammers floated in the air before my eyes, and I had a great wish to have the author of that article within range. . . .

Once in a while I noticed a "dig" at relay work, taken in some articles in RADIO NEWS, but I presume that they slipt in without being noticed, but the author of "Let's Go" must certainly have it in for the great amateur body.

Regarding the publishing of "Calls Heard" lists, etc., I think you have the right idea. The way the subjects are handled by the various radio magazines just about suits me, and I cannot see how anyone else can find fault. I like RADIO NEWS because it has interesting news about commercial stations and very interesting articles written by the foremost personalities in the radio profession. Please understand that the only thing that I didn't like was this "relay-experimental" affair, but I hope it will be all cleared up by now. Well, Mr. Editor, thanks for this space in your magazine. I shall now QRT and let some other fellow amateur use the space for his grievances.

H. S. GOWAN,
Kitchener, Ontario.

The Phantom Call

By R. A. CHATH

"HEY, Muller."

"Yeah?"

Say, Mayer fell down on that article, 'Signals From Mars,' for the *Sunday Illustrated;* sheet's about as full o' pep as a dead fish; haven't a darn thing snappy enough to fill in with. You were a wireless man when you were in the Navy, weren't you?"

"Uh huh."

"Well, see if you can dig up a live one along that line, will you? Fleet's up the river for a visit. Ought to be an operator or somebody aboard one of those battle wagons, who can give you some material; and don't forget, we go to press at eight P. M."

Claude Muller, one time naval radio operator and now special writer for *The Hemisphere,* walked disconsolately back to his desk and dropt into the chair.

"Doggone it all," he exclaimed, "here I've been roosting all day long, with nothing to do but gaze at this bunch of would-be scribes grinding out jazz copy, and now, at half-past four, that pie-eyed zebra of a Sunday editor has to hand me an assignment about as concrete as a hunk of Hudson River mist; and I've got a date with Vita for supper at six. However, I reckon I'll have to get him his story somehow or other."

* * * *

"Hello, Sparks! Pretty classy set this old destroyer's got."

Operator Bill Clement of the U. S. S. *Roosevelt* turned to survey his questioner. "Yes, it's one of the latest types," he replied with a smile.

"Busy?"

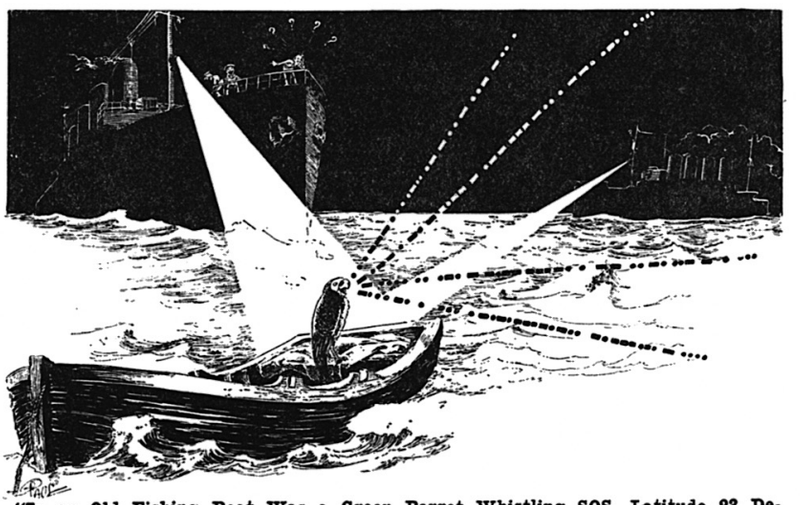
"No, sir. I'm off watch now. Just lookin' for the makin's. I'm sure I left 'em here right by the fones, but hanged if I can find—a cigar? Sure! Thanks! Beats the makin's any day. How's that? Well, yes, radio *is* mighty interesting. I've been in the game—that is the navy end of it—ever since the coherer days and it's gettin' better all the time, and now this new fone stuff—huh? No-o-o, haven't struck much that's mysterious. There's one thing that's always been a mystery to me—why some Limey with a spark like a steak fryin' asks for three QTA's, when you're about thirty leagues away, usin' five K.W., and shootin' it to 'em at ten words a minute, thru clear air. Jokin' aside tho, I guess the most mysterious thing I ever heard was down off Guantanamo.

"It was about three years before the war, while the fleet was havin' Spring manœuvres. I was 'op' on the old *Bentley,* which at that time was one of the class A destroyers. The department was just beginnin' to take an interest in direction finders or goniometers as they called 'em then. The *Bentley* and her sister ship, the *Rockman,* had both been fitted with these compasses and ordered out on a three day practice cruise to see how good we was at findin' each other. Sort'a like a game of tag. First she'd signal and we'd try and find her by usin' the goniometer, and then we'd signal and she'd come hoppin' after us.

"Well, the contraption works out O. K. and we both heads about and makes for port.

"Now, after evenin' mess gear, I was up in the shack listenin' with one ear and chewin' the fat with the bo's'n. I'd been sittin' there, I guess, p'r'aps half an hour, when the skipper rings m'bell and hollers down the voice tube, that we'll make port by three bells and to shoot the glad tidings to the base. I throws the main line and antenna switches and while waitin' for the generator to get up to speed, I reaches up and closes the port-light over the receivin' set for the sea's actin' up some nasty and some spray's startin' to come in.

"Well, I sits down again and starts to call NAW. No sooner'n I press the key, but for some unknown reason, the bo's'n hauls off with both fists an' belts me an awful crack on each side of the head. Of course, I'm *some* resentful and turns around to lay him out cold, when I hears a guy with a peach of a five hundred cycle note callin' SOS. Lettin' the bo's'n go for the time bein', I turns back to the set and copies down this bird's call. Seems he's S. S. *Lloyd George* on fire in latitude twenty-two degrees, thirty-one minutes, nine seconds north, longitude seventy-five degrees, twenty minutes, nineteen seconds west. I rings up the bridge and gives the skipper the dope. He damn near yanks the engine room telegraph out by the roots and away we goes.



"In an Old Fishing Boat Was a Green Parrot Whistling SOS, Latitude 23 Degrees, 31 Minutes, 9 Seconds North—Longitude 75 Degrees, 20 Minutes, 19 Seconds, West, as Neat as Any Human 'Op' Could Do It."

"Pokin' my head out the door, and glancin' aft, I sees the *Rockman* from the course she's layin', and the speed she's makin', has got the call too.

"Well, soon's I clears the bridge, I opens up on six hundred, with full power and informs this bird that we're headed his way and hittin' the high spots. No comeback. 'Guess he didn't hear me,' I says. I tries it again. Nothin' doin'. I switches to three hundred with just as bad results. Then young Fricke on the *Rockman* tries his luck at it and gets as much satisfaction as me. Meanwhile, this jazbo is squirtin' the ether full of yells for help at about two minute intervals.

"I'm beginnin' to get a suspicion there's somethin' phony goin' on, so I tells Fricke to get this guy's true bearin' with his radio compass, whilst I do the same. After gettin' the angles, I rings up the bridge again—tells the skipper my suspicions and asks him if he'll stick the angles on his chart and see if the, 'fix,' checks up with the position this Limey's chirpin'. Sure enough, it does, right to the dot.

"Well, after scootin' along for a while, we finally reaches the scene of the trouble. Nary a ship is in sight except the *Rockman.* No rockets, no lights, nothin'. Skipper orders the search-lights manned and starts combin' the water for small boats. Pretty soon, about a half a mile to lee'ard, we spots a dinghy of some sort and there's somethin' sittin' in it. We mosey's over at half speed and what do you think we finds? An old dinghy from some fishin' boat or other and perched in the stern sheets is the biggest green parrot I ever see. An' that there bloomin' bird is whistlin' SOS an' latitude twenty-two degrees, thirty-one minutes, nine seconds north—longitude seventy-five degrees, twenty minutes, nineteen seconds west—as neat as any human 'op' could do it.

"I'm so surprised I gets sort of dizzy. First thing I knows, I hears somebody say, 'he's comin' to.' I opens my eyes an' there I am layin' in a bed in the sick bay, and it's broad daylight.

"'Hello there, Billy,' says the orderly, 'how you feel?'

"'Pretty good, except my head hurts,' I replies. 'What the hell am I doin' here?'

"'Why, seems when you reached up to close the port light las' night, you got a bight of your fone cord fouled around the antenna switch an' when you went to send that message for the old man, you got a flock of juice thru your bean.'

"'Shucks,' I says, disgusted, 'I thot that was the bo's'n's fist.'

"'Say, that high potential juice is worse than wood alcohol, Jimmy! Gosh! What a nightmare it gave me!'

"Another cigar — yes, thanks, they're mighty good smokes. Going? That's too bad, I just thot of another little incident—some other time, maybe."

* * * *

"Here's that story you wanted," said Muller, as he laid the copy on the editor's desk.

"Huh, you sure didn't lose any time, did you?"

"Couldn't afford to, got a date at six."

"Looks pretty good, hm—hm-m. Yes, that'll do," he growled.

"Hey, boy—here, take this down to Johnson and tell him to rush a proof."

"Say, by the way, Muller, how did you get that stuff so quick?"

"Used my head."

"Huh?"

"Used my head. Wrote it out of my think tank."

"You son-of-a-gun, I thot you made that trip darn quick. Go on, beat it, it's a quarter of six. If you keep her waiting, she'll get sore.

"An' say," as an afterthot, "give her my love."

"You bet," yelled Muller, as he streaked it for the elevator.

Junior Radio Course

The Three-Element Vacuum Tube—Third Part

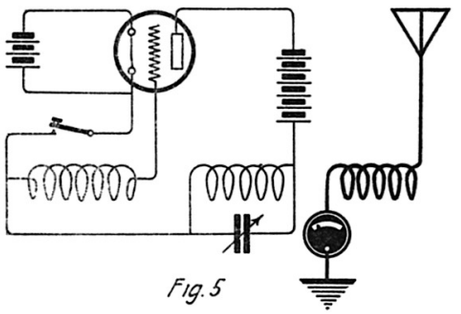


Fig. 5

Practical Circuit of an Undampt Wave Transmitter. The Aerial is Coupled to the Oscillating Circuit.

IN this lesson, the third on the subject of the three-element vacuum tube, the functioning of the V. T. as an oscillator will be described. We will at first explain the principle; then its application in the transmitting circuits as generator of undampt oscillations and in the receiving circuit as a detector-oscillator connected in a regenerative circuit.

The diagram, Fig. 1, is the typical hook-up of an oscillating circuit in which sustained oscillations are produced by a V. T.; there again the same phenomenon, as explained in the previous lesson, happens, that is, *the grid acts as an interrupter*, opening and closing the circuit a tremendous number of times per second.

To understand what follows, we must remember the induction laws which are so that if in one of two circuits placed close together, an interrupted current flows, a current of *same direction* is induced in the second circuit *at make*, while *at break* this induced current flows in the opposite direction.

This is what happens in a spark coil, which is well known by every radio amateur.

This being understood, we can see in Fig. 1 that, according to the theory already explained, the D. C. of the battery B flows suddenly in the circuit, P. F. O. L2, when the filament is lit up, but this current passing thru the coil L2 induces a current in the coil L1, which is connected to the filament and the grid. This induced current flows as shown by the arrow in Fig. 1, consequently impressing a negative voltage on the grid which at this negative potential stops the electrons flowing from the filament to the plate. The current from the battery B, traveling from the plate to the filament, is therefore stopt, for it has no more the flow of the electrons on which to travel.

At this point, which corresponds to a break in the plate circuit, a current flowing in the other direction being induced in the grid coil L1, the grid is made positive and *helps* the electrons to reach the plate, and the same phenomenon is reproduced, keeping in the circuit oscillations of constant amplitude.

The curves in Fig. 2 make this very clear; curve A shows the variation of potential in the plate circuit. When the filament is lit up, the current starts to flow in the plate filament circuit; while this current increases, the current inducted into the coil L1 (curve b) increases also, but not at the same time owing to the self-inductance of the coil. It was explained in the previous lesson that a small change of potential of the grid is sufficient to cut out the flow of electrons; therefore we may see that at point X corresponds the grid potential for which the plate filament current stops, but still owing to the same self-inductance effect, the grid current doesn't stop at once but increases again down to point Z, while the plate filament current rapidly falls to 0. This sudden drop induces a stronger current flowing in the opposite direction in the grid coil, which makes the grid positive. The grid being positive not only lets the electrons flow, but at the same time *helps* them to reach the plate. As the current on the grid is only momentary, it falls again to zero and the same process is repeated for each impulse.

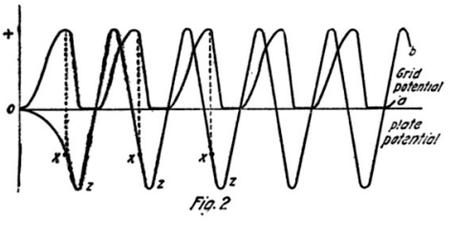


Fig. 2

Curves Showing the Variations of the Grid and Plate Potential in a V.T. Oscillator.

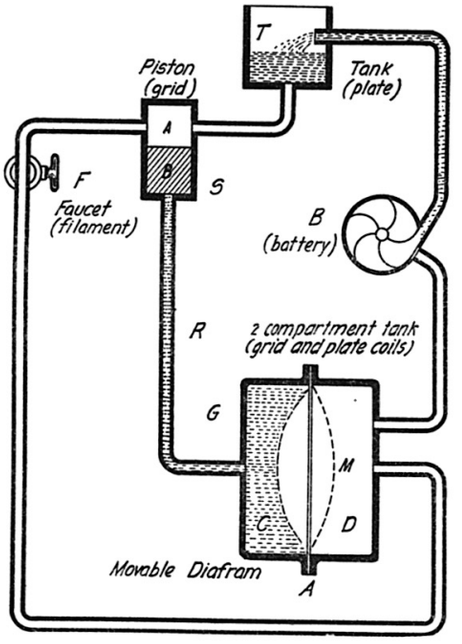


Fig. 3

Simple Analogy Explaining the Functioning of a Vacuum Tube as an Oscillator.

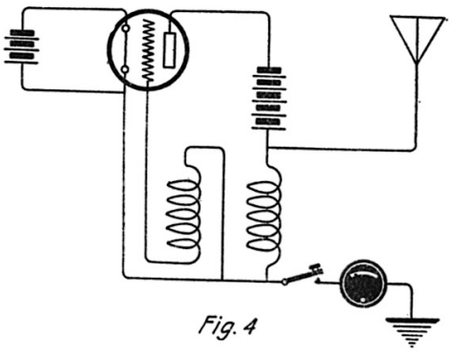


Fig. 4

The Elementary Circuit of a C.W. Transmitter.

ANALOGY

In order to explain the phenomenon happening in the vacuum tube oscillator, we shall use the same analogy as in our previous lesson.

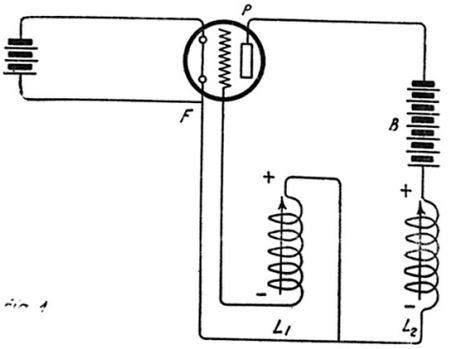
In Fig. 3 the plate circuit is represented by the endless pipe, while the grid circuit consists of the compartment C of the big tank and the pipe R, which is connected to the cylinder S.

If the faucet F is open, the water from the tank T flows suddenly into the pipe and the diafram, separating the two compartments C and D in the tank G, is deflected to the left; the water contained in C being compresst pushes the piston B up to position A, thus stopping the flow of water. The elastic diafram then comes back to its normal position and goes farther to the right, up to position M, pulling by suction effect the piston B down on the cylinder, thus helping the water to flow again. The same play continues, making the diafram vibrate constantly.

PRINCIPLE OF THE C. W. TRANSMITTER.

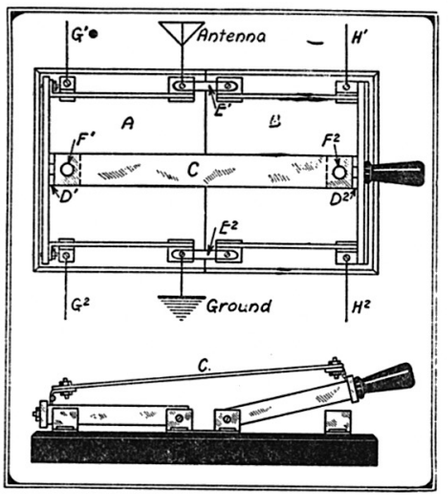
If we connect a capacity to the circuit in which sustained oscillations are produced, it will be noted that a current flows in this circuit. We may therefore use an aerial and ground as a capacity and send undampt signals by connecting or cutting out this capacity by means of a key, Fig. 4.

(*Continued on page* 571)



The Typical Circuit for Producing High Frequency Undampt Oscillations With a V.T.

Junior Constructor



Don't Waste Your Energy Throwing Your Antenna Switch. Make it This Way and Save Time.

A SMALL "THROW" AERIAL SWITCH.

Here is an original design for an antenna switch.

The switch is designed from an amateur's point of view, taking cost of material and simplicity in construction into consideration. It consists, primarily, of two double-pole, single-throw switches, the bases of which can be of porcelain or, if a more elaborate switch is desired, slate bases are recommended.

The main feature of this switch is its quick action and small "throw." The angle of throw can be reduced to a minimum and can be adjusted from a throw of 10 degrees or 15 degrees to a full throw of 90 degrees or even more. When using the switch with only a small angle of throw, 40 degrees or less, it can be placed in a neat mahogany box with only the handle protruding. Adjustment of the angle of throw is accomplisht by either lengthening or shortening the brass strip C. By lengthening the strip the angle of throw is lessened and shortening increases the angle.

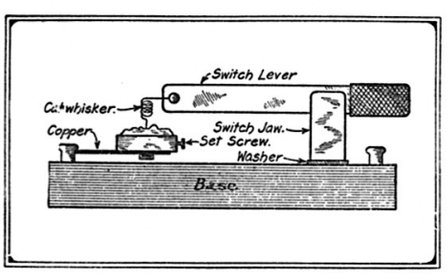
My experience has shown that an angle of 20 or 30 degrees is about right for quick action and ease of operation. The angle of throw is so much reduced in this type of switch that the change from sending to receiving, or *vice versa,* can be made almost instantly.

The switch handle of one of the switches is removed and the same bolt used to fasten the small hinge that attaches the brass strip C to the switch crossarm.

A and B, double-pole, throw switches; C, flat brass strip, 3/32 x ½ inches times length of switches; D_1 and D_2, brass hinges ½ inch long; E_1 and E_2, small brass strips, hole in each end; F_1 and F_2, ½ inch brass bolt, 8/32 thread; G_1 and G_2, transmitting; H_1 and H_2, receiving.

I think that without any further description I have made things clear, as the drawing is practically self-explanatory, and I hope this will meet with approval.

Contributed by EDWARD J. WURTZ.

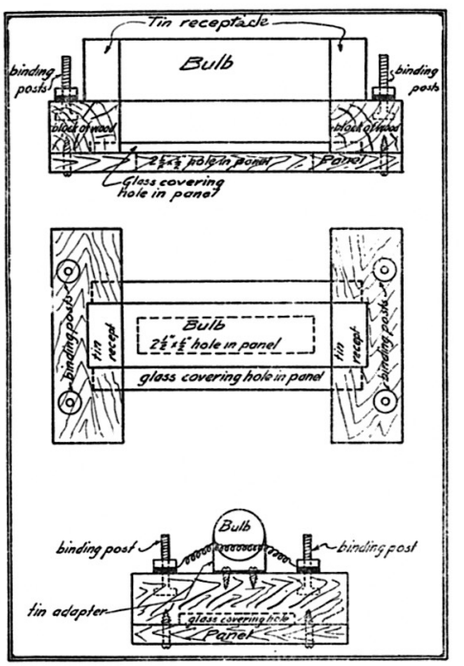


Here it is Boys, a Real Cheap Detector Made From an Old Switch.

A SIMPLE BUT EFFICIENT ADAPTER.

This adapter for audiotron and other tabular bulbs may be best suited for inside mounting of bulbs altho it may also be used for outside mounting. All of the parts used in the construction of this adapter can be readily found in the experimenter's workshop.

First, two pieces of wood each three inches long, one inch wide, and three-fourths of an inch thick are required. Two holes are then drilled one-half inch from the end in each piece to receive the binding posts or machine screws. The heads of the screws should be countersunk below the surface of the wood so as to avoid their touching the panel. Next two pieces of tin each three inches long by one-half inch are cut and formed into a U shape. One is screwed to each piece of wood and they form the holders for the bulb. On the opposite sides from these a slot one and one-fourth inch wide is cut in each piece to hold the glass which covers the hole in the panel. Two holes are then drilled in the panel and the two blocks of wood are mounted. The adapter is then ready for use.



Here is an Easily Built Adapter for Your Audiotron. A Good Idea for Mr. Smallpocketbook.

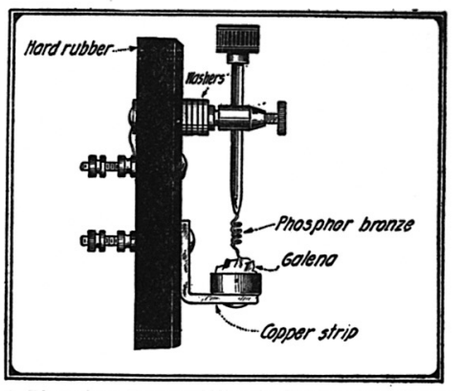
If the amateur is compelled to buy all the parts it should not cost over ten or fifteen cents, while he would be obliged to pay a dollar or a dollar and a half for a receptacle if he bot it.

Contributed by HAROLD W. KAPPELER.

A PANEL DETECTOR

This detector is made for panel use only, as many sets are built without a detector. The back is cut out of an old phonograph record cut to size on drawing. The holder for the crystal is a small brass cup bolted onto a copper strip which is fastened to a battery binding post extending thru back. The rod is held by a binding post held out by four washers to keep the knob off the panel. This post is connected thru the back to another post on the other side. A crystal of galena is held in the cup by a soft metal known as hugonum.

Contributed by F. G. CAMPBELL.



A Phosphor Bronze Wire is Soldered to Brass Rod for Contact with Crystal

A SIMPLE DETECTOR FOR THE BEGINNER.

An inexpensive and finely adjustable detector can be made from a baby knife switch with very little difficulty. The base is 2" x 4" x ½" on which is mounted a switch jaw with washer between it and base so that it will move freely and make good contact. The switch lever with insulated handle is removed from the pivoted jaw and a bolt run thru the hole. The cat whisker is fastened to this bolt. The cup is taken from the top of the carbon of an old dry cell and threaded for set screw. The cup is fastened to a strip of copper which in turn is connected to binding post and connection made. This detector can be used for galena or silicon by using a stiff point for silicon or the cat whisker for galena. If the detector is nickel-plated, it will make a fine looking instrument.

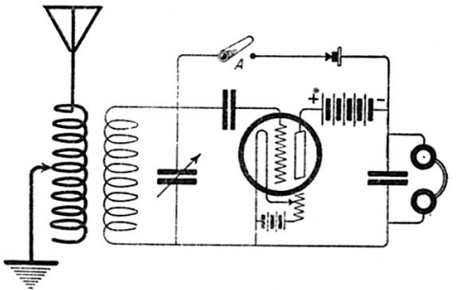
With a little experimenting it will be found that many angles of adjustment can be obtained.

Contributed by W. E. MERCK, JR.

AUDION CRYSTAL HOOK-UP

Having had very good success with the hook-up, shown in the accompanying illustration, which describes a simple method of changing from audion to crystal reception, I believe other amateurs will be pleased with the result they get if the directions shown in the sketch are followed. To make the change, the filament rheostat is turned off and switch A is closed. As only one switch is used in the operation, it is unnecessary to have an elaborate system of change-over switches, which is an advantage for the amateur.

FRANCIS S. WILLIAMS.



A Simple Way to Change From Audion to Crystal Detector; Only One Switch is Necessary.

ELECTROLYTIC RECTIFIER.

(158) Mr. William Feustel, Passaic, N. J., asks:

Q. 1. Can a bank of four electrolytic rectifiers as described on page 117, in the September, 1919, issue of RADIO NEWS be used to supply the D. C. on the plate of a V. T.?

A. 1. Yes, such a rectifier may be used providing a fixt condenser of about .008 mf. is connected across the D. C. source. A diagram of it appears on this page.

Q. 2. How can this current be regulated down to about 50 volts?

A. 2. This may be accomplisht by means of a carbon potentiometer of the same type as those used with B batteries.

RADIOFONE OPERATING ON A. C.

(159) Mr. Clifford Hansen, of Chicago, Ill., asks:

Q. 1. Please show a hook-up of a radiofone operating on A. C. with a rectifying device delivering 500 volts for the plates.

A. 1. A hook-up for the radiofone is publisht on this page.

BUZZER TRANSMISSION.

(160) Mr. Joseph McCarthy, of Newtown, Conn., inquires:

Q. 1. Where can I get phonograph records for learning the code?

A. 1. We suggest that you write to the Wireless Press, 68 Broad Street, New York City, which sells such records.

Q. 2. Would a buzzer directly connected in an aerial be suitable for short range transmission?

A. 2. A simple and efficient buzzer transmitter diagram is publisht on this page.

LOOSE COUPLER DATA.

(161) Mr. Andre Freich, of St. Pierre-Miquelon, asks the following:

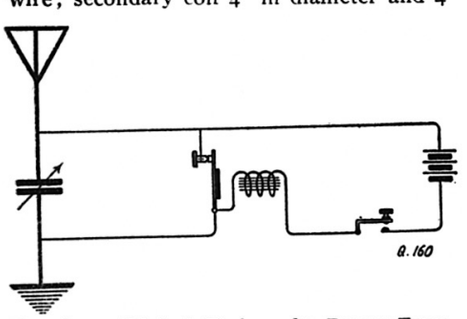
Q. 1. May a galena detector be used in connection with a V. T. as an amplifier?

A. 1. Certainly. The primary of the amplifying transformer is connected in place of the fones in the detector circuit. This hook-up has been publisht several times in the pages of RADIO NEWS.

Q. 2. Can a loose coupler be built for a wave-length of from 600 to 2,500 meters? If so, kindly give data.

A. 2. Such a loose coupler should be built as follows:

Primary coil 5" in diameter and 4" long wound with 200 turns of No. 24 D. S. C. wire; secondary coil 4" in diameter and 4" long, wound with 325 turns of No. 28 D. S. C. wire.



Here is an Efficient Hook-up for Buzzer Transmission. The Aerial Circuit May Be Tuned by Means of the Variable Condenser.

AERIAL WAVE-LENGTH.

(162) Mr. George Malone, of San Rafael, Cal., wants to know:

Q. 1. What would be the wave-length of an aerial 200 feet long and 50 feet high, composed of two No. 14 wires spaced six feet apart?

A. 1. The natural wave-length of such an aerial would be about 300 meters.

Q. 2. In a diagram publisht for question 117 in the November issue of RADIO NEWS, what are the battery and transformer in the microfone circuit?

A. 2. The transformer is a modulation transformer and the battery, connected in series with the primary and microfone, is about four volts.

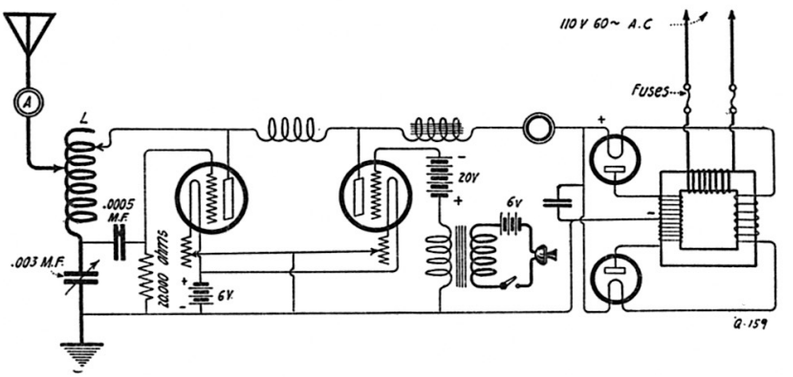


Diagram of an Efficient Radiofone With One Tube Modulator and One Oscillator. The H.T. D.C. is Furnisht by a Rectifying Device Composed of a Transformer and Two Rectifier Tubes.

FORD COIL TRANSMITTER.

(163) Mr. Charles Martini, Jr., of Philadelphia, wants the following information:

Q. 1. Is it permitted to send with a Ford spark coil when the station is located about eight miles from the border of another state?

A. 1. Yes, it is permitted to send messages so long as you don't interfere with the radio traffic of other states. The transmitting set should be tuned to 200 meters maximum and radio laws should be observed in transmitting any messages.

Q. 2. Is it possible to use A. C. stept down to six volts for filament of a V. T.?

A. 2. Yes, such a device was described on page 447 of the January, 1921, issue of RADIO NEWS.

Q. 3. Please publish a diagram of a receiver using a V. T. detector for the reception of undampt waves and a crystal detector for the reception of dampt waves.

A. 3. A hook-up for such a set is publisht on this page.

BURNT OUT V-T.

(164) Mr. Charles R. Cosse, of Mt. Vernon, N. Y., desires to know:

Q. 1. Is it possible to repair a burnt-out V. T.?

A. 1. It is possible to repair a burnt-out V. T. by fixing a new filament and enclosing the electrodes in a new glass bulb. This is rather difficult work to be done by an amateur not having the necessary tools and we suggest that you write to the Vacuum Tube Repair Co., 511 Perry Building, Oakland, Cal., which makes a specialty of repairing broken tubes.

CONDENSER CAPACITY.

(165) Mr. F. C. Start, of Toronto, Can., asks the following questions:

Q. 1. What is the capacity of a condenser section composed of six sheets of thin brass 8" x 6", separated by seven glass plates, 8" x 10" x $\frac{1}{16}$"?

A. 1. The capacity of such a section is about .002 mf.

Q. 2. How many of the above sections should I use with ¼-k.w. transformer with a sending voltage of 8,000?

A. 2. One section is sufficient with a transformer of this power.

GRID CONDENSER.

(166) Mr. Elmer Johnson, of Wausau, Wis., wants to know:

Q. 1. What is the correct grid condenser capacity for a Marconi V.T. Class 1?

A. 1. The capacity suitable for a Marconi V. T. varies with the circuit employed. A grid leak should be used, shunted across the condenser. Grid leaks of various resistances should be tried, but if a variable condenser is used a resistance of about two megohms is suitable.

Q. 2. What is the wave-length of an aerial 60 feet long and 55 feet high, composed of four wires? The wire used is No. 12 gauge.

A. 2. The wave-length of an aerial of this type would be about 150 meters.

STEP-DOWN TRANSFORMER

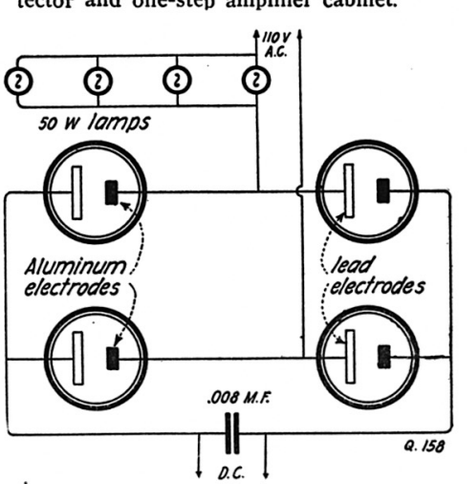
(167) Mr. Richard L. Rohrer, of Lititz, Pa., asks:

Q. 1. May a step-down transformer be used to supply the current to an audion bulb instead of the batteries?

A. 1. Yes. See the article on this subject which appeared on page 447 in the January issue of RADIO NEWS.

Q. 2. May a detector and one-step amplifier be combined with a two-step amplifier to form a detector and three-step amplifier?

A. 2. Yes. The primary of the first transformer in the two-step amplifier is connected in place of the fone to the detector and one-step amplifier cabinet.



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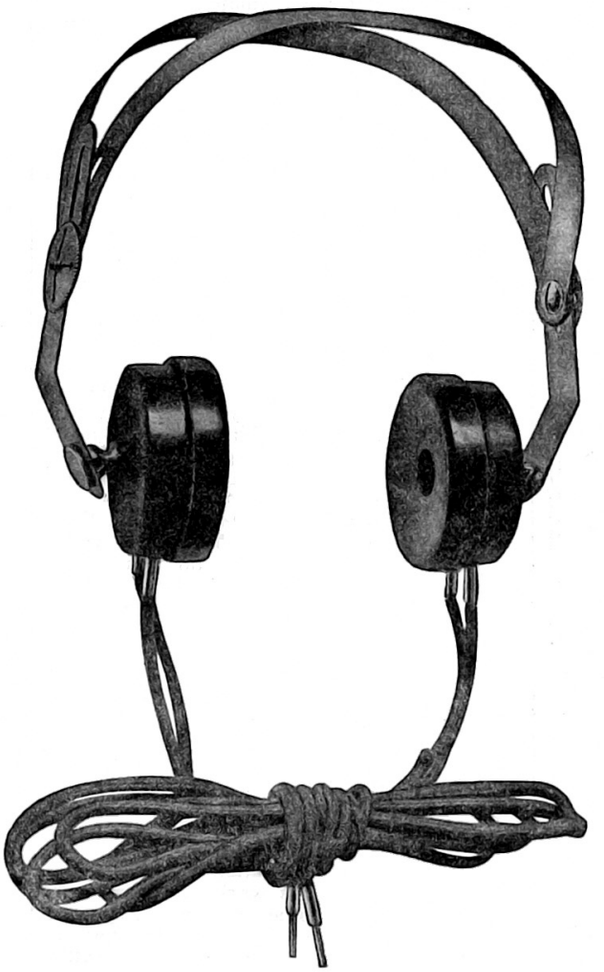

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Amateur Radio and Its Future

(*Continued from page* 519)

The idea seemed to be to discourage candidates rather than to help them along as is done today. A few brave souls after a day or so of hard work eventually had the sets almost running, but the great majority gave it up and were afterwards told to go home and study up on wireless.

RADIO GETS IN PUBLIC EYE

These may be said to have been the "Middle Ages" of radio; the awakening point, we might say. Amateur, as well as commercial radio, was being recognized as an important factor in the development of this great country; that is why our law makers saw to it that some of us did not break our necks in attempts to outdo each other. As you all know, amateurs were allocated wave-lengths of 200 meters and the commercial boys were assigned to 600 meters and above.

More attention was paid to tuning. The straight coupled sets were junked and the tuning transformer or "jigger" became law. Still there was no great need to worry for the number of amateur and commercial stations had not reached the great number we have today.

Slowly but surely, the insidious bite of the radio bug began to have its effect. Thousands of boys and young men who previously had had nothing better to do than to spend their evenings at the corner poolroom became infected with these most prolific germs.

Radio magazines began to appear on the news-stands and were publisht far and wide until today there are no less than seven of them in the United States alone, each one of which has a rapidly increasing circulation. These magazines, by the way, have done a great deal to spread the glad news concerning amateur radio.

IMPORTANT PART OF AMATEURS

It is perhaps interesting to know that many of our leading engineers began as amateurs, while the great majority of the commercial operators and commercial men in general, likewise began as amateurs.

A short time ago I had the good fortune to be sent to the great Radio Corporation transmission station at Marion, Mass. The marvelous work that this station is doing is another feat to the great monument of radio science. I was awed by the sight of the ponderous 200-kilowatt alternators which deliver an antenna current of 425 amperes and which work continuously each twenty-four hours of the day with Nauen and Stavanger, Norway.

I was equally impresst by the spectacle of the fourteen 395-ft. masts which hold the flat top antennae.

I was still further impresst when informed that of the 17 persons attached to the station, no less than five were formerly amateurs, in fact, one of them was one of the boys who used five kilowatts of power to make himself heard while in upper New York back in the happy days of 1908.

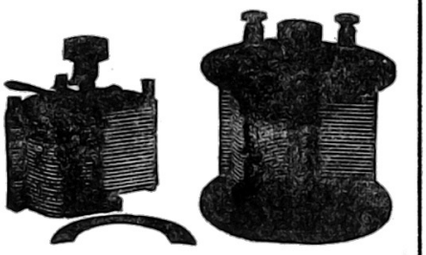
Thus you are faced with the importance which government and private radio organizations place upon the beginners and amateurs.

The war probably did more than anything else to bring this important fact before the attention of the authorities as we shall soon see.

WAR BIG CHANCE FOR AMATEURS

Following closely upon the so-called "Middle Ages" of radio came the war. Here indeed is where the amateur proved his worth and all future legislation whether favorable or unfavorable to the amateur must fully realize and take into account

(*Continued on page* 546)



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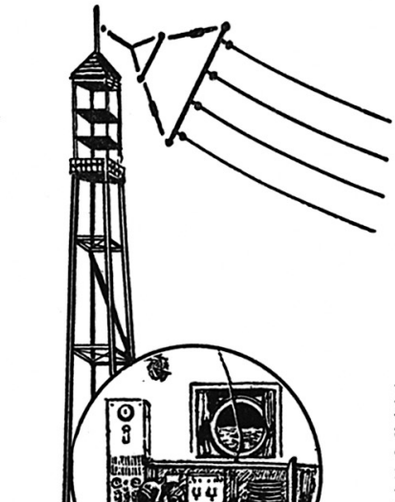

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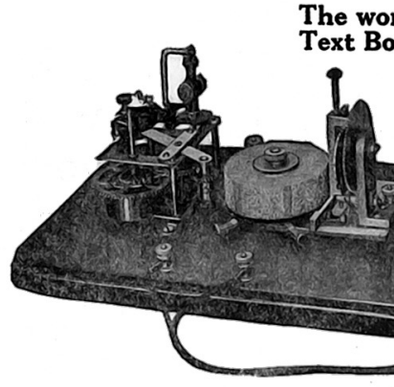

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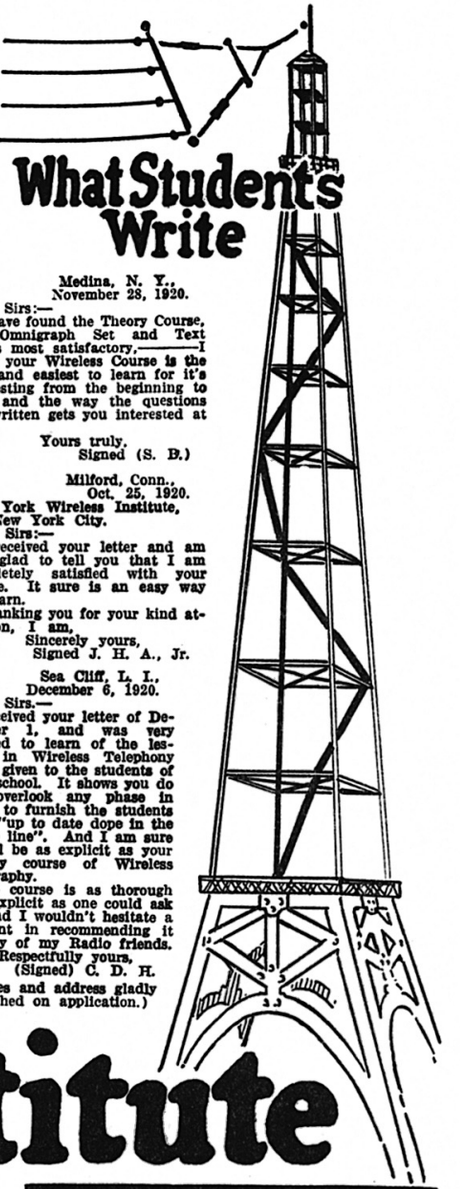

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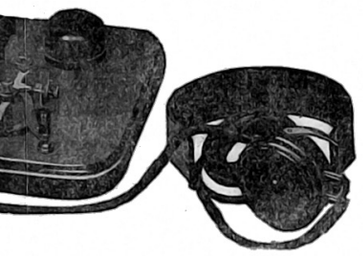

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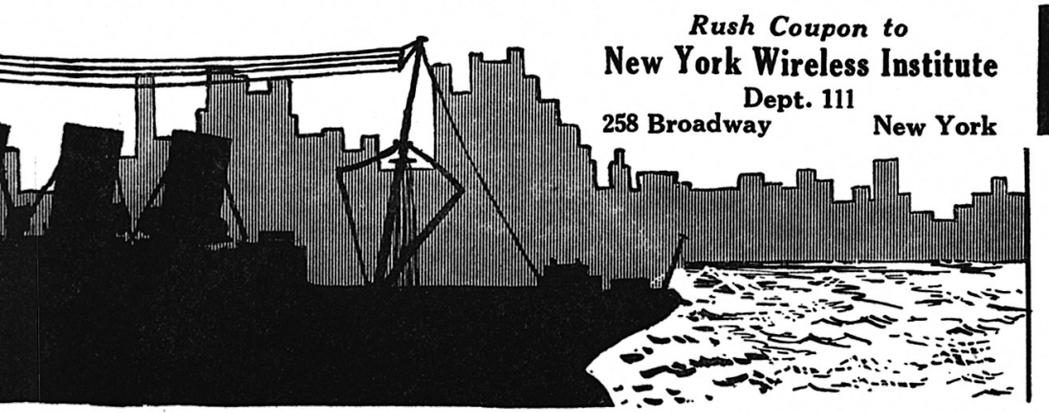

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(*Continued from page* 542)

the potential assistance he is in a position to render during moments of emergency.

The government called upon the radio amateurs to fill the ranks of both the Navy and Army Signal Units, and all those who could possibly do so, that is, those who were not too young or who did not have dependents, quickly responded.

As a matter of fact some of the most important positions were filled by amateurs who had never had either governmental or commercial radio experience. I myself have nearly one hundred friends and acquaintances who rose quite high in army and navy rank, such as captains and majors in the army and junior and senior lieutenants in the navy.

Even so, there were not enough amateur or professional operators to fill the ranks of a great army and a great navy, so many additional newcomers were trained.

I understand that the U. S. Signal Corps alone trained something like 50,000 men in the theory and operation of the modern radio installation, while the Navy probably instructed 20,000.

These young men are now back in civilian life and are scattered over all parts of the country and cities. Needless to say every one of them in a more or less degree has experienced the keen fascination and the many thrills known to the radio enthusiast. Incidentally the greater part of them became amateurs, they set up complete receiving and transmitting sets in all parts of the country and are now keeping in touch with the game, advancing with the art of radio telegraphy and telefony.

CONSIDERING INTERFERENCE

Now we come to the most important part—that of interference. With such a great number of amateurs there is bound to be constantly increasing interference, and the amateur wave-length of 200 meters has really become too small to hold them, so to speak. This is particularly evident in thickly populated districts such as New York, Boston, Chicago and elsewhere. One has only to "listen-in" any evening to hear the medley of sparks and fone "hellos" to become fully convinced.

This subject of interference is an old one and I am not the first one to think of it by any means. I understand that it is being seriously considered by the powers-that-be and we may soon expect a rearrangement of amateur wave-lengths and possibly a stricter method of supervision.

The bill known as S4038 which Senator Poindexter introduced at the last session of Congress would seem at first glance to be out for the suppression of amateur transmitters located too close to coastal, transoceanic, or government radio stations, and this bill has received considerable objection from amateur quarters. I hardly think this measure is as severe as may be imagined. The fact that "no land station, amateur, experimental or training school shall be located in such a manner as to interfere with coastal, transoceanic, or government stations" does not necessarily spell the doom of the amateur; it is merely a precautionary measure for future occasions and with the practical radio tuning of today there is little danger of an experimenter's 200 meter wave interfering with the 600 or 1200 meter waves of commercial or government stations unless, of course, the amateur is situated next door to the commercial station which is hardly ever the case in practice.

LEGAL ATTEMPTS AGAINST AMATEURS

These attempts to squelch the amateur are no new wrinkle. Every so often, a representative or senator at Washington will introduce a "trick" bill of some sort designed to curb our activities. As far back as 1909, which is nearly twelve years ago, this interesting pastime of introducing bills against amateur radio began with the so-called Depew bill. Of course, in those days there was absolutely no regulation or laws of any kind for the control of amateurs and even tho the number of experimenters was comparatively small, there was beginning to be need of some sort of government control.

At any rate, today we must be very careful and conscientious in the manner in which we operate our transmitters. No broad tuning mind you, and a sharp eye must be kept on the happy side of 200 meters.

Receiving, of course, is different. If every one of the one hundred and ten million inhabitants of the United States set up solely receiving sets and did not use transmitters there would be no trouble and no need of supervision unless, of course, someone comes along and tells us that the combined energies radiated by so many vacuum tube receiving circuits would jam the American ether to the choking point.

AMERICAN AMATEURS FORTUNATE

We are very fortunate in this country not to be hindered as are our less fortunate European brothers. We are free to send and receive to our heart's content provid-

(*Continued on page* 548)

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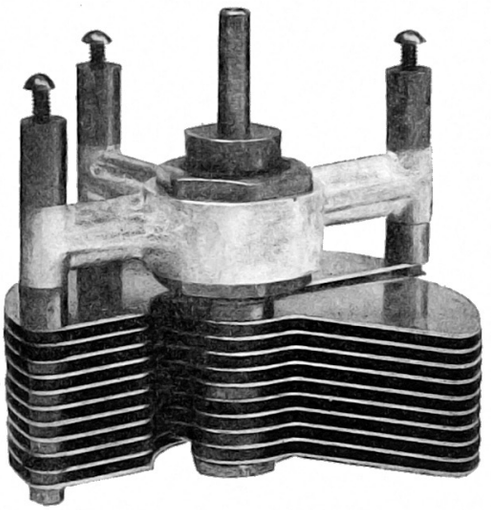

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ing we obey certain laws and regulations.

Our Canadian brothers are somewhat less fortunate, for what can one do in the line of transmission with 50 meters?

England and Australia, I understand, are beginning to loosen up with their amateurs, but still their laws are far from favorable when compared to ours.

France limits its amateurs to the reception of time signals and meteorological reports only, and one must not copy commercial or government messages, for this is against the law. However, there will need to be a great number of radio detectives to censor what an amateur is receiving.

Holland also permits amateur reception but no transmission.

Germany, on the other hand, does not permit any amateur activity whatever.

So you see, fellow amateurs, how fortunate we really are in this country of the brave and the free.

Let us now say a few words concerning the future of radio amateurs. While editor of RADIO NEWS, I often received letters from amateurs in all walks of life asking just how one could use his amateur knowledge and experience to advantage, that is to say, realize some commercial value out of it. Unfortunately we cannot all be Marconis, DeForests, Alexandersons and Pickards. Some of us must of necessity remain radio wall-flowers.

OPPORTUNITIES IN RADIO FIELD INCREASE

In spite of this distressing fact, however, there is no need to despair. There are at present thousands of opportunities in the radio field which did not exist five, ten and twelve years ago. This game has become an exact science and there are many sub-divisions of it. In other words, one must specialize in any given branch of it in order to really be someone.

We have today specialists in radio reception and radio transmission. These are subdivided into specialists in low-power transmission, high-power transmission, short wave and long wave reception; spark, arc and alternator experts, vacuum tube experts, loop antenna experts and so on. Any one of these subjects holds the possibility of further research and development and will be the task of our future radio engineers.

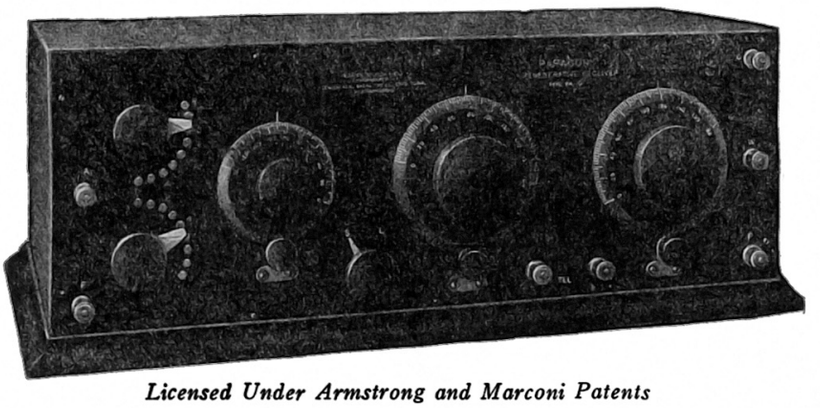
There are some who say "this radio is a great game to play with but there is no money in it." There *is* money in it but you must work for it. There is as much remuneration, if not more, in the commercial radio industry of today as there is in many highly specialized professions. Not only that, but the pay is rising instead of falling.

GOOD PAY FOR OPERATORS

Just think of it; back in the old days, six years ago let us say, an operator went to sea for $25 and $30 a month; today he is paid $100 and $125. Surely the cost of living has not increased five times what it was in those days. Don't forget, by the way, that in addition to the present good pay there are included food and living quarters as well.

One does not necessarily have to go to sea. There are plenty of opportunities on shore, be they in construction, inspection, manufacturing, selling and even operating fields of radio.

It would be foolish to say, of course, that every individual amateur should strive to secure a berth in commercial radio. There are surely too many amateurs, and not enough positions to go around. Furthermore, there are many types of amateurs and the number who find their way into the commercial ranks are very few indeed in comparison. The greater part use radio as a hobby and at the same time it is an excellent mind trainer. There are some, of course, who are in the allied branches, such as the electrical, the telegraph and telefone fields.



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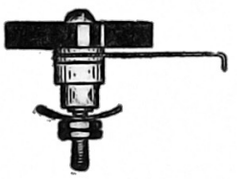

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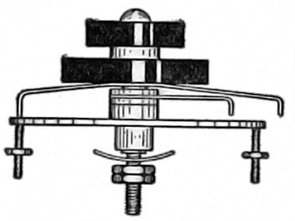

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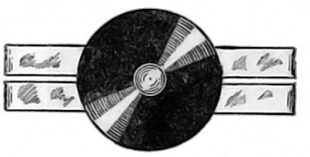
A compound switch consisting of two electrically independent switches mounted with concentric knobs. 1½" radius brass finish $1.10. Nickel finish $1.25.



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A rotary panel switch which is double pole and double throw. Will change variable condenser from series to parallel, etc. 1½" radius brass finish 75c. Nickel finish 85c.

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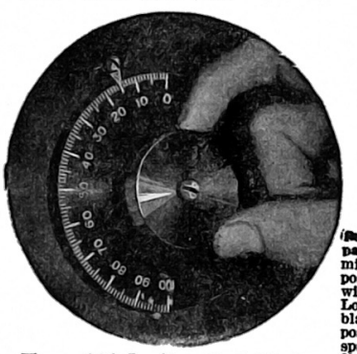
A complete unit for back of panel mounting. The latest and best in rotary panel switches. Better looking, more efficient and easier to mount. Complete with Type 116 Dial and 6 contacts $2.25. Complete with Type 116 Dial and 11 contacts $2.50.



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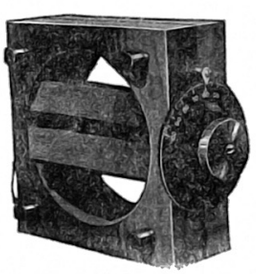
Suitable for table or back of panel mounting. Has turned aluminum case, convenient binding posts and 6 ohm resistance unit with all off and all on positions. Long bearing and special designed blade insure smooth running and positive contact. Only occupies space 2" in diam. on your panel. No. 121A with Type 116 Dial $2.50. No. 121B with Knob and Pointer $1.75.

Type 14B Rotary Disk

The same style rotor as used on our famous belt driven gap, only with bakelite center and brass bushing to fit your motor shaft. Size is 4⅝" diam. and 9/16" thick. This rotor being light and perfectly balanced will give excellent results on any small high speed motor. State size of shaft when ordering. No. 14B Rotary Disk $6.00.

Variocoupler Rotor

A carefully turned hardwood form for the secondary coils of variocouplers, etc. Size is 3½" in diameter and 2" wide. No. 101 Rotor $1.00.



Type 5A Variometer

Made from Wilcox Variometer parts, completely assembled as illustrated, may easily be mounted on panel if you wish. Wave length range in average circuit with coils in series about 175-450 meters. No. 5A Variometer $8.

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The point I am trying to get at is, that if you are really desirous of entering the commercial ranks of radio there is plenty of room for you, and no doubt you will secure as much success here as in any other branch.

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Fig. 1 shows a miniature tho practical instrument which has done more for the advancement and development of radio than any other instrument. It is the vacuum tube which has rightly been called the modern Aladdin Lamp. It is certainly wonderful, for it is capable of more feats than any other electrical appliance.

Mr. E. F. W. Alexanderson, who developed the high frequency alternator making long distance transmission possible, recently voiced some thots in connection with the vacuum tube which are vivid and interesting. "Scientists tell us that electricity is no longer the mysterious power fluid that we have imagined flowing smoothly in our wires. Instead it is composed of miniature planets or comets of condensed material electricitv of definite charge and mass shooting across a miniature universe inside of a glass bulb and following orbits that can be calculated as accurately as the orbits of the planets."

IMPORTANCE OF VACUUM TUBES

Fellow amateurs, this little bulb which is hardly larger in size than a cigarette, or any one of its mates of possibly larger dimensions is destined to revolutionize future radio and it will not take very many years either. It will not only benefit and change present systems of commercial radio but it will prove an excellent stimulus to amateur radio. A word of advice—go easy on the purchase of spark equipment.

Amateur radio is on the way to become even more popular than amateur photography. As you see the man or woman promenading in the park on Sunday afternoon carrying the inevitable little camera case, so will you see the future amateur carrying his little case which will contain sufficient apparatus to communicate by radio over comparatively long distances within the city or country.

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I have tried to secure some authentic information concerning the number of amateurs in the United States today. As near as I am able to ascertain there are over 200,000 amateurs of all classes and the number is constantly increasing, due probably to the excellent publicity that is being given to radio, not only thru the medium of the radio magazines themselves but in the daily press of the country.

FIGHT FOR YOUR RIGHTS

In closing I can give you no better counsel than to ask you to keep closely in touch with radio not only thru reading but experimenting as well. Invest a few dollars occasionally in apparatus, particularly in the latest equipment. It is an excellent investment whether you intend to remain an amateur or whether you have aspirations to become a professional.

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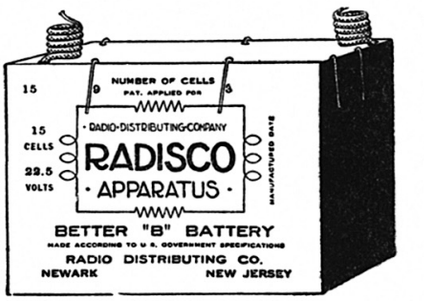

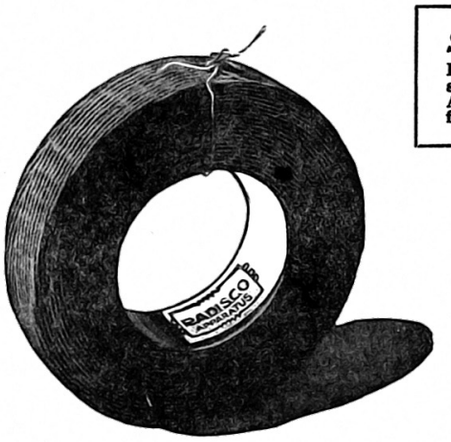

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curb the activities of American Amateur Radio, rise as one and fight to the last ditch against such measures. In this connection your radio magazines and the officers of your associations and clubs will always do their utmost to keep you informed on such propositions as they may present themselves and, therefore, give you ample time to vigorously resent it by writing strong protests to your representative at Washington. Remember the unreasonable curbing of amateur radio is un-American and certainly not symbolic of liberty and freedom.

Keep your ears well glued to your receivers and don't be caught napping. Remember that others are constantly listening-in.

Two Practical Radiofone Circuits

(*Continued from page* 518)

the anode circuits of V_1 or V_3 or both. By connecting a third valve V_2 in the position shown, radio telefony may be obtained. The valve V_2 will damp the oscillations in L_2 since it will conduct when the oscillations make the anode of V_2 positive. The degree to which V_2 will conduct will be approximately proportional to the grid potential of V_2. This grid potential is varied during speech transmission by the E.M.F.'s supplied by the microfone M and the step-up transformer T. From this we will see that the oscillatory potentials applied to the grid of V_3 will be modulated. The circuit of Fig. 1 may be varied experimentally in various directions. The anode of V_2 may be given a positive potential by including a source of potential between the foot of L_2 and the filament. Another variation is to connect its foot of the secondary winding of T to a point on the grid leak R, so as to give the grid of V_2 a negative potential. The method of using single filament and anode batteries is frequently employed. The filament battery is also made to act as a microfone battery.

ANOTHER PRACTICAL RADIOFONE CIRCUIT

The second radio telefone circuit which is capable of giving very excellent speech depends on an entirely different principle. The actual high frequency oscillations are not modulated or interfered with, but the output of the amplifier tube is controlled microfonically. Fig. 2 shows the arrangement. A master oscillator tube V_1 is again used. The input circuit L_2 of the amplifier tube V_2 is coupled to L_1. The grid of V_2 is given a high negative value by taking a connection from the grid leak R. The microfone transformer T is so connected that the normal or "base-line" grid potential of V_2 is continuously varied when speaking into M. Let us assure that—E volts are required to cut down the anode current of V_2 to zero, so that the tube V_2 is being used at the foot of its grid-potential—anode-current curve. Let us now consider that the amplitude of the induced oscillations in L_2 is E volts. If the grid base-line potential be made—E-e volts, the induced oscillations will never produce any oscillatory current in the outfit circuit of V_2 since even the positive peaks of the oscillations only bring the operating point to the foot of the curve. If, however, we apply additional positive potentials to the grid, the grid-base-line potential will become less negative, and the oscillations will cause the operating point to travel up and down a portion of the anode current curve. Oscillatory currents will be generated in the anode and aerial circuits having an amplitude corresponding to the amount of the curve used. This will depend upon the magnitude of the added potentials which are in practice the low-frequency potentials supplied by the microfone transformer T.

Both of these circuits, particularly the second, have proved of considerable value for medium powers and can be recommended for this purpose. The present writer has produced some distinctively original radio telefone systems which have produced particularly pure articulation and it is hoped that an opportunity to discuss these will occur in the near future.

How to Wind Duo-Lateral Coils

(*Continued from page* 518)

side and so on. Only the first three turns are shown in the figure. Wind the first layer in this way, omitting every other pin all the way around. When the second layer has been reached take the next pin to the last one for one turn only around the tube and then start omitting every other pin again. Thus the second layer will be wound on an entirely different set of pins and this will bring the turns of the second layer exactly over the space between the turns of the first layer. When the third layer has been reached switch back to the row of pins the first layer is wound upon, and so on for all the rest of the layers. On the top row of pins shown in the figure the odd numbered layers will be wound on the odd numbered pins and the even numbered layers on the even numbered pins. There will be a slight irregularity on one turn of each layer, but this is not objectionable as it is only one turn in twenty-five and cannot be noticed.

When finisht the coil is shellacked, cut off the tube, the pins pulled out and is ready for mounting. If the coil has been carefully wound it presents a very neat appearance.

An Old Idea Exploded

(*Continued from page* 519)

gave about the same results after the other adjustments were completed. The same was found to be true of the steady voltage introduced into the grid circuit of the amplifier circuit at C. This voltage was obtained from one Edison battery cell. Its value was a little over one volt. The principal critical adjustment made was that of the potentiometer R_2. Best results were obtained with plate voltages in the neighborhood of 35 to 40. After obtaining the best possible results from these a further small, but appreciable, increase was obtained by *partially* inserting an iron wire core into the "air-cored" amplifier transformer. This last gain is that to be due to audio frequency tuning, and probably in part to audio frequency regeneration.

In the tests with the preceding circuit two soft tubes of the same make were compared with four different hard tubes. Of these hard tubes, three are commonly used as detectors and amplifiers, the fourth as a (five watt) power tube. The two soft tubes were found to be very nearly alike in spite of the fact that prior to the experiment one of them was carelessly allowed to roll off of a desk and drop nearly three feet onto a linoleum floor.

In comparing the best results obtained from the soft tubes with the results obtained from the hard tubes it was found that the soft tubes were giving higher amplification than the three hard amplifier tubes. The results from the power tube closely approached those from the soft. Testing weak signals from a buzzer set about 100 yards away, an amplification as high as fifty (audibility) was frequently indicated. On detuning the receiving loop just enough so that the signal in the detector circuit became totally inaudible, a readable signal of audibility six was found in the amplifier circuit.

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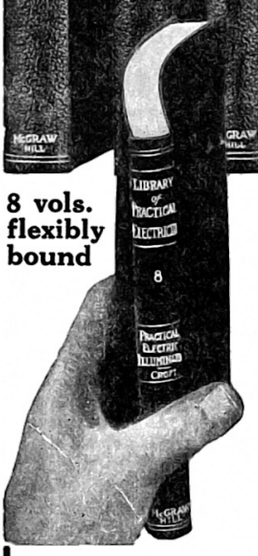

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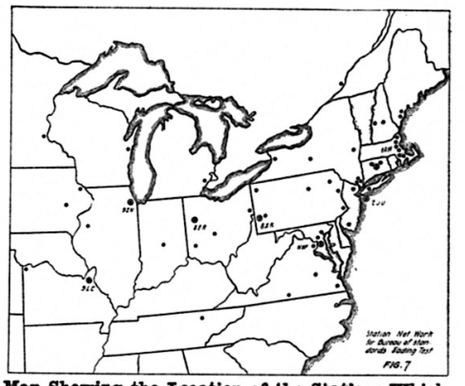
A 500-cycle dynamic test of the tubes used gave amplification factors ranging from five to twelve, that of the soft tubes being about ten.

Fading of Signals

(*Continued from page 529*)

Once having got under way, after the elapse of two days, all stations transmitted their test schedules regularly. The average distance of communication was 400 miles. No station used an input in excess of one kilowatt and the communication was at 250 meters where static is most pronounced. An average of 26 recorders were faithful in the performance of duty each night, with 20 observers being the minimum on any occasion. Half of the schedules listened for were copied in the form of 1,260 curves of sufficient merit for tabulation in the final count. The test schedule consisted of the alphabet, each letter sent five times at a speed equal to 18 words a minute, allowing three minutes for communicating the entire alphabet. As each letter was received the operator noted on a chart the intensity at which it was heard, so that when the schedule was complete a curve had been secured showing the swinging during the three-minute period. Mr. Kruse admits that the intensity scale employed was not all that was to be desired. The method used was: Buzzer transmission of the actual schedule was sent thru the primary of an ordinary coupler to the secondary of



Map Showing the Location of the Stations Which Were Used for the Test of the Bureau of Standards on the Fading of Signals.

which two headsets were connected in series. The operators independently recorded the intensity of the signals which was varied during transmission by altering the coupling. The curves were alike with reservation for difference of judgment as to the average strength of the signals. The Bureau of Standards describes an actual test as follows: At 10 p. m., eastern standard time, all the sending stations listened for time from Arlington. At 10:10 the first station at Hartford, Conn., made a long QST call, saying repeatedly, "Bureau of Standards—A.R.R.L. Fading Test." Both the call and notice were repeated, then the stations started to send the test schedule, repeating each letter five times. Tests were made three evenings of each week, each recorder on duty filling out one curve sheet for each sender he could hear. L. C. Young, of the Radio Laboratory of the Naval Air Station, suggested the method of using dots for each letter and drawing in the curve at a subsequent time. In practice, attention is thus riveted on each letter and the inclination for the pencil to drift is forestalled. Weather conditions are revealed by the charts when checking the proper words at the lower left corner of the sheet. The first impression that atmospheric conditions could be recorded by use of symbols was discarded as impractical, inasmuch as the recorder was unable to note signal and static strength at the same

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It takes the place of any single, double or triple-slide tuner or coupler made. It is more efficient, being inductively coupled. Just the thing for **Wireless phone work.** To tune above 300 meters take condenser out of ground lead and shunt it across aerial and ground. Just the thing for the beginner—or advanced amateur to listen in with as you will hear more signals than with any tuner you have ever used. Special introductory price $6.00. Add parcel post.

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700 M to 5000 M— 10.00—add P. P.—Type A. S.
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These tuners need no advertising as they are used all over the world.

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Assemble them and save money.

11 Plate.....$1.80
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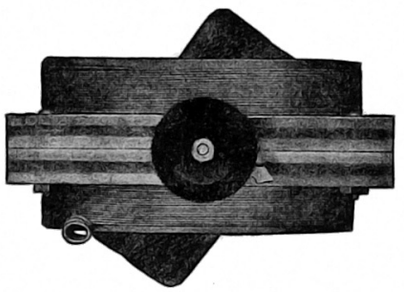
41 Plate..... 3.20 Add P. P.

If you want us to assemble them for you add $1.00, plus P. P., to above prices. Shipping weight 2 lbs.



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Use them in your set or with our tuner $5.00, add P. P. Weight 3 lbs.

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The RTS Grid Condenser is the best Grid Condenser obtainable. It is as far above others in quality, workmanship, and design, as the Aeroplane, compared to a Horse for speed.
WHY?—Because we have designed and constructed different types until we produced the only reliable Grid Condenser. It is constructed with lead and copper foil, completely mounted on heavy insulating material.
DON'T FAIL— to look for the sign RTS when buying your Grid Condensers. If your dealer has not already stocked RTS Grid Condensers, order direct from us.
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YOUR ORDER for one of our condensers will bring our SPECIAL MONTHLY LETTERS, and circulars.

RTS—.0005 M. F. GRID CONDENSERS—ea. 30c., postage 3c.
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WE GUARANTEE

Each RTS Grid Condenser to prove satisfactory, and to do better work than any types now on the market. We guarantee this condenser to give 5 years' service under ordinary use, and will gladly replace or refund your money if you are not satisfied.

RADIO TESTING STATION, - Binghamton, N. Y.

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time. Swinging of the radio signals was frequently more rapid than at first anticipated, and the idea of using a check mark for each group of letters proved inadequate.

After the first week of the operations—the curves of the initial seven days being meaningless—results of the tests began to unfold. Anomalies peculiar to various sections of the United States developed. Notably, the fading of signals in New England was violent and rapid. The severity of the swinging lessened as one went south or southwest and in Pennsylvania, Ohio, Indiana, Illinois and Michigan the fading was not nearly so pronounced. According to types the Bureau of Standards outlines three classifications of swing: A very rapid and abrupt fading which seems as if the sender were skipping one or two letters. Another kind of swing is where moderation obtains and a more gradual type which gives curved lines almost entirely, the period being from ten seconds to five minutes. This manner of swinging is common. Still another classification is that of a very gradual drift of all stations in one direction from the recorder, a cycle consuming from five minutes to a number of hours. The first-mentioned type of swing is interpreted as a one-station phenomenon. The second kind of fading is most exasperating, one unit swings in while another is going out. The station being copied is blanketed before it goes out of audibility. In the third type of swinging, all sending stations not far removed from each other fade slowly together. Where the fading is extremely slow it was observed that in the early portion of the evening stations in one direction will be heard more clearly while units in another direction are inaudible. The latter condition is characteristic of the Mississippi Valley.

Fading of radio signals is not restricted to land, as indicated by a test over water. Curves were obtained at Fort Pierce, Fla., on board the U. S. S. Ohio, then 150 miles east of Cape May, N. J. Then, too, there are traveling curves; that is, one which appears successively at different recording stations. The same "dip" in the curve which appeared in New York City reached Buffalo, N. Y., Norfolk, Va., Woodhaven, L. I., and Clifton, N. J. Such an anomaly occurred at different times and where there was a well-defined direction of travel of the curve it was away from the sending station.

Here is the theory evolved by the Bureau of Standards as to the cause of swinging or fading signals:: The variations are caused by varying reflections and refraction of the waves. A cloud, fog bank, or a mass of fumes from an industrial plant may operate in the capacity of interference bands. To illustrate, the tests revealed rapid and erratic swinging of the Pittsburgh station. The assumption is that fumes from smelters or steel plants may congregate in such masses as to act as reflectors. However, stations at Salem, Ohio, and at Wheeling, West Virginia, located in a district not altogether dissimilar from that of Pittsburgh, did not duplicate these rapid fading signals. The Pittsburgh station swinging is not attributable to the sending apparatus, as one recorder may note from 15 to 28 swings from the Smoky City, others will hear three or four. The conclusion of Mr. Kruse is: "Reflecting need not necessarily be involved in the production of interference bands. Refraction will answer just as well to change the direction of the waves if we can find a mass of vapor whose dielectric constant differs from that of the normal atmosphere thru which the waves are traveling. Neither the reflecting nor the refracting body need be at high altitudes. They may be at the elevation of the sending and recording sta-

tions and to one side of the line joining them."

It is repeated that fading is a long distance phenomenon. Persistent efforts to secure fading between Bristol and Hartford, Conn., only 12 miles apart, were futile. The intensity remained uniform and the signal did not evidence the slightest trace of weakening. Like observations were noted in the transmission of messages from New York to Woodhaven, L. I., and from Washington to Anacostia. It is not to be assumed that fading is subject to fixt distances. Transmission conditions may influence short distances as illustrated in wireless communications between Baltimore and Washington, only 40 miles apart. Violent signals render difficult radio operations between these two cities on wave-lengths below 500 meters. Similarly, successful communication is not obtainable between Lawrence, Kan., and St. Louis, Mo., 120 miles distant. The opinion is expresst that fading does not occur in general within the daylight range of a station, the Washington-Baltimore example being an exception to the rule.

The massed opinion of the recorders, whose voluntary services made the radio swinging tests a success, is that fading is not a variation in signal strength but a shift of wave-lengths. They explained that a station which had swung out could be recovered by retuning the receiving set. A request was issued to desist from this practice inasmuch as it would be impossible to tell whether the variations in receiving signal strength were due to a change in incoming power or attributable to mistuning. A laboratory check of this practice gave positive evidence that two observers could not get results even approaching similarity if the receiving apparatus was retuned during the test. Therefore, tuning was finisht before the tests were undertaken.

By way of summary, the story of the tests of short wave radio signal fading is: Tests were conducted three nights each week during June and July, six sending stations operating at 250 meters' wavelength. Observations of the intensity of the signals were duly noted by 50 recording stations. For 21 evenings an average of 28 recorders listened for the test schedules, obtaining for examination 1,260 curves of signal intensity variation. Traveling curves were positively identified; while no intimate relations between weather conditions and transmission were establisht. Three types of fading were unfolded, with abrupt fading being characteristic of New England. Sending sets do not lend themselves to any particular manner of fading altho a dampt wave that has faded out can frequently be recovered by retuning. Finally, there is a preponderance of evidence that radio signal variations such as fading and swinging are caused by varying reflection and refraction of waves.

Using an Amplifier as a Detector of Long Waves

(*Continued from page* 528)

when using honeycombs and three bulbs. I copied their "communique" and their press to 9ZN without missing a letter. I could also tune in another station or two with this hook-up.

The explanation of this phenomenon is not hard to find. The open circuit consisted of the aerial, the primary of the first amplifying transformer, and the ground. The first amplifying tube became a detector, and the second tube acted both as amplifier and as heterodyne oscillator. Or, rather, the local oscillations were produced by an interaction between the two amplifying circuits. At any rate I could hear

The new Turney Circuit, used exclusively on Turney Units, produces as much amplification with a one-step amplifier as has formerly been secured with a three-step! Our new booklet explains it.

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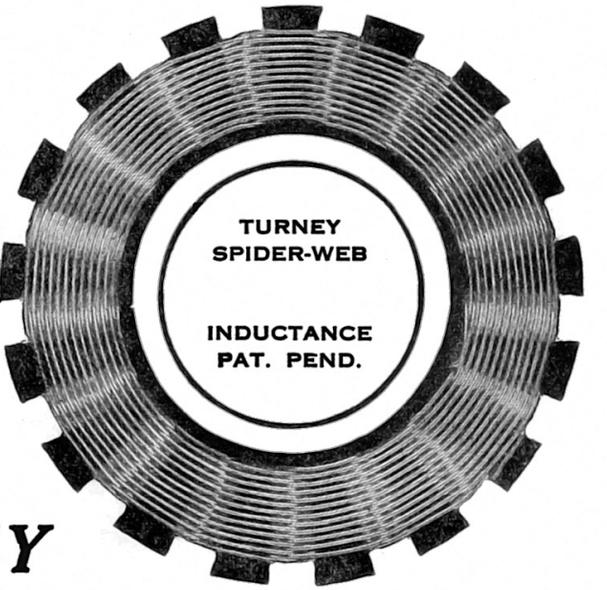

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SPIDER-WEB INDUCTANCE COILS
Built at Radio Hill—

UP AT the foot of the Berkshires, amid inspiring surroundings, nestles Radio Hill. This ideal radio location is the scene of the development of the Turney Spider-web Inductance Coils. Here, far from any outside influence, Eugene T. Turney, *Radio Engineer,* the man who developed the Crystaloi Detector, has brought forth a sensational improvement in machine wound coils.

Below is shown the Turney complete receiving unit. It contains three Spider-Web Coils, the secondary and tickler being adjustable to the primary. The doors are capable of exceedingly fine adjustment. Six Binding posts allow for almost any type of circuit. With two condensers, of .0005 m.f., this unit will respond to wave-lengths of 175 to 400 meters. The results will give you a new idea of radio efficiency.

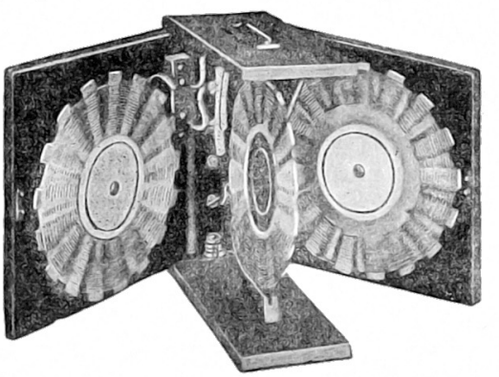

Illustration shows front of cabinet removed

Formica Insulation Thru'out Patent Pending

Dimensions, 4½ x 5 x 1¾

PRICE SIX DOLLARS COMPLETE

Order direct from this advertisement. Send check or money order for $6.00 plus postage, and your Spider Web Unit will come forward at once. OR write us for circular, explaining the Spider Web principle in detail.

Progressive dealers are invited to write for our interesting sales offer on Turney Complete Receiving Units.

THE WINDING

showing angle at crossing. This style of winding has four distinct and exclusive advantages.

1. MORE INDUCTANCE—There is no magnetic leakage in coupling. The coils are flat, and the entire magnetic area is available.
2. LESS DISTRIBUTED CAPACITY. The wire runs parallel for a greater distance, and crosses itself less frequently than in any other coil known.
3. LOWER HIGH FREQUENCY RESISTANCE. There being no interior magnetic field, or air core, high frequency resistance is reduced to a minimum.
4. OCCUPIES LESS SPACE. The coils are so thin that three of them are less than ¼ inch in width.
5. MORE AMPLIFICATION. Repeater action, caused by tickler flux passing thru Primary to excite Secondary.

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RADIO HILL, HOLMES, NEW YORK

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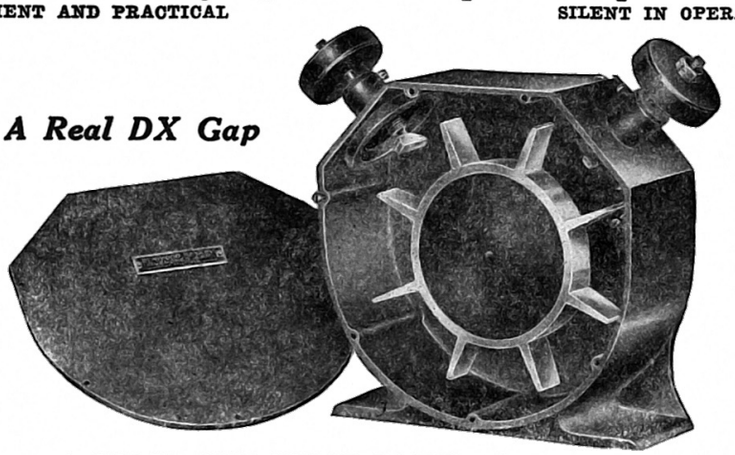
Rotary Quenched Spark Gap

EFFICIENT AND PRACTICAL SILENT IN OPERATION

A Real DX Gap



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Something entirely original in spark gap design, at a price that you can afford to pay.

Stronger and lighter than aluminum. No metal being used in casting thus eliminating any and all electrical losses. Scientifically correct in every detail. Impossible for insulation to ever break down. Guaranteed for life.

Disc weighs only ½ pound, yet it has the same sparking surface as the larger BENWOOD discs that are so well known thruout the country. Dimensions are, 6 inches in diameter, ¾ inch in width and the teeth or sparking surface are tapered down to less than ⅛ inch in thickness. This gives the "quick break" that is theoretically proper and so highly desirable. Smallest fractional H/P/ motor will drive the gap with ease. Furnished complete with flexible coupling all ready to connect to any motor, regardless of size. Furnished with 4, 8, 12 and 16 point rotors, merely specify type desired.

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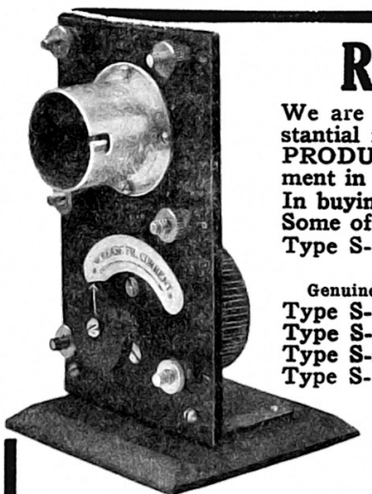

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Genuine Bakelite Panel, Navy cage type rheostat and socket.

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of the proper resistance is indispensable for operating efficiency with any vacuum tube detector. Our radio engineer has designed a variable grid leak which will help you get increased signal audibility. Every radio man will want at least one of these leaks. Order today to insure prompt delivery. Does the work of six ordinary grid leaks at less than the usual price of one.

TYPE S-40 VARIABLE GRID LEAK 75c
(From .5 to 3 Megohms)

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Type S-24—Aluminum Socket only..... $.50
Type S-10—Single Tube..... 1.10
Type S-3—Double Tube..... 2.50
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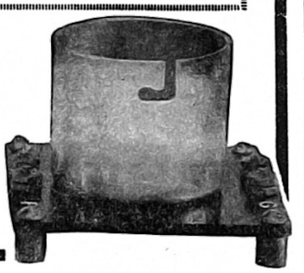

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nothing using one stage alone. The condenser in Fig. 3 increased the feedback, and by the way, a condenser connected in this way between the plate of the last amplifier and the aerial will often increase the audibility of signals in other circuits, such as that of Fig. 1.

The most surprising thing about the experiment is that *coils with iron cores are used in the radio-frequency circuits.* This proves that waves 15,000 meters or more in length have a low frequency, that iron cores do not materially decrease the efficiency, and in fact that they may increase it with waves as long as that of LY (23,500 meters).

I would be glad if others would try this, and see what they can find. It may be that a better built amplifier would not have the necessary interaction between the circuits, and that other makes of transformers would act differently. Those used in the set at Miami are Federals.

A New Thermionic Vacuum Tube

(*Continued from page* 528)

ted from F. A millimetre in the G circuit corroborates this assumption. This effect is far more markt than in the case of an ordinary valve, since the plate is more suitable for the absorption of electrons. The G current, however, does not build up immediately, but only becomes important when the G potential is higher than about +2 volts. We consequently see why the anode current curves of Fig. 2 only commence to lean over to the right when the control potential passes +2 volts. To the right of the zero ordinate, the curves, it will be noticed, become less regular. When the control potentials reach higher values than those shown, the anode currents reach a saturation value, and then begin to de-

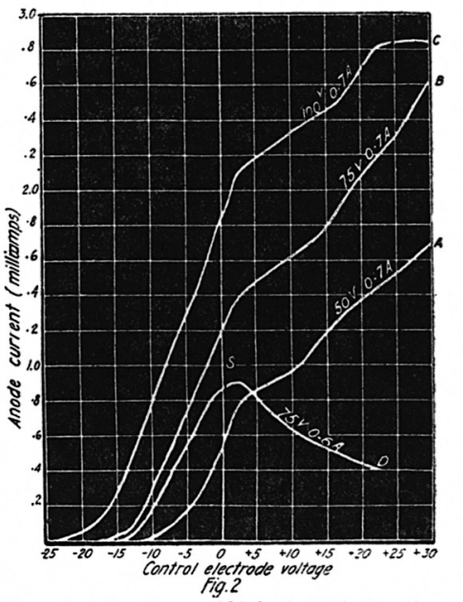

Fig. 2

Characteristic Curves Obtained With the New Type of Vacuum Tube Having 2 Plates Acting as the Grid and Plate of a Normal Type V.T.

crease. This effect is shown in Fig. 2 by the D curve obtained by applying 75 volts to the anode and lessening the filament current from 0.7 amp. to 0.6 amp. The maximum anode current is reached at S. As the control electrode is given higher positive potentials, the anode current falls. Electrons which formerly went to the anode are now being drawn to the control electrode. It will be seen from the curves that an increase of anode potential displaces the anode current curve bodily to the left. In several other ways, the curves obey laws similar to those governing the characteris-

tics of valves having grids placed between filament and anode.

It might at first be thot that the result of placing the control electrode behind the filament would be that an increase of control potential would partially neutralize the attraction of the anode, and so cause a decrease of anode current. This is what happens in the case of a valve described by Mr. J. Erskine-Murray, but the very opposite occurs in the writer's type of valve, which operates in the normal way. We may explain the action of the valve as follows: The filament F working at, say, 0.7 amp., is emitting a certain number of electrons per second. The anode P is capable of drawing to itself a certain proportion of these electrons. The remainder would be wasted, and would float around the filament and the inside of the bulb, especially behind the filament. These spare electrons would constitute a negative space-charge around the filament, and would tend to lessen the number of electrons passing to the anode. The effect now of applying a negative voltage to the control electrode G would be to repel many of the free electrons back into the neighborhood of the filament, and so concentrate the space-charge; this in turn would lessen the anode current. When the control electrode is positive it will attract to itself most of the electrons constituting the space-charge, and so cause an increase in the anode current. It is also certain that the electrostatic field of the control electrode extends itself on the other side of the filament, and this helps to explain the action of the valve.

A special condition is shown in the D curve. The anode current is now saturated, and practically all the electrons emitted from the filament are being drawn to the anode. By placing a positive potential on the control electrode an opposing attraction will be exerted on electrons actually on their way, or intending to proceed, to the anode. These electrons will be deflected to the control electrode, and the anode current will suffer in consequence. The anode current curve, therefore falls, and it is to be noted that in this valve the anode current only decreases with an increase of control potential, when the latter potential is positive, and when the sum of the anode and control electrode currents is equal to the total emission from the filament. The same effect is obtainable with an ordinary valve, but the comparatively sharp bend at S is far more marked in the case of the writer's valve. This is easily explained by the fact that G is a large metal plate, far more capable of absorbing a large electron current than a very fine wire open helix.

Judging from the curves given, the amplification obtainable with this valve is not as high as in the case of the more usual pattern, altho the actual results in a three-valve amplifier were almost as good. The representative point should preferably move only along the left-hand portion of the curve. The valve operates well as a detector, the point S being especially suitable for strong signals, both half oscillations producing a decrease of anode current. The vacuum tube also operates excellently as an oscillator and self-heterodyne receiver with 100 volts on the anode and 6 volts across the filament. No doubt, the characteristics and general properties of the valve could be greatly improved by further research on the sizes and relative positions of the electrodes.—*Abstracted Electrical Review.*

HE OUGHT TO BREAK ALL "RECORDS"

Spark: I wonder why 9XYZ has such a musical note.

Lark: Why, he's using a phonograph record for his rotary disc.

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Ask him to open up one unit.
You'll see the equivalent of a phonograph reproducer in conjunction with the famous Baldwin balanced armature movement.
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They are actually *hand-calibrated* to absolute accuracy—yet, are low priced.
All ranges in flush type finished in highly polished nickel. They match one another and are the neatest and most accurate miniature meters made.
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If you can't afford a pair of Baldwins this season, we recommend Brownlies.
Ask the salesman to remove one ear cap.
You'll see, among other things, the 8 supporting springs, the 1000 ohm solenoid under the exact *center* of the diaphragm.
One professional operator says about his Brownlies:
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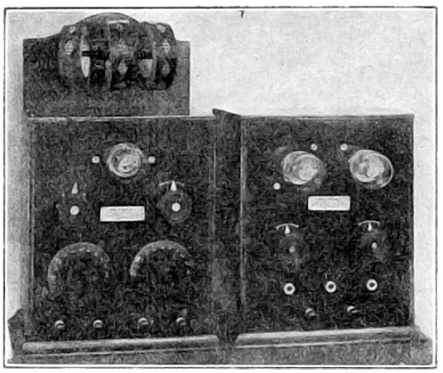

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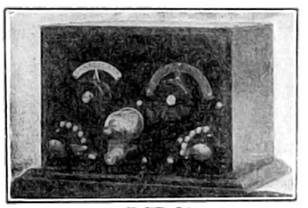
The Reynrad RR-74 Multiwave Tuner and Audion Detector, used in conjunction with our RA-72 Two Step Amplifier makes an exceptionally sensitive and efficient receiving equipment. The RCR-30 Crystal Detector receiving set is the ideal equipment for those who do not wish to purchase the more expensive outfit.



RR-74 RA-72 RCR-30

The RR-74 Receiver, $55.00; with Audion Bulb....$60.00
The RA-72 Two Step Amplifier, with bulbs..... 55.00
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With 3,000 ohm phones..... 30.00

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Wound on 4-inch Bakelite tubing with standard De Forest Plugs to fit your DeForest Coil Mountings. A set of three will bring in amateur stations and an additional secondary coil will make your receiving outfit equally efficient up to 600 meters. State wave length desired, 150-300 or 300-600. Short Wave Coils $2.00 each.

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In test of our C. W. Transmitter, signals were copied at this distance. (Details on request.)

Complete transmitter mounted on grained formica panel 10 x 14 x 3/8, including motor generator, 4 A-P transmitting tubes, filter device, filament heating transformer, microphone, antenna current ammeter, plate current milliammeter and all necessary controls, etc., $395.00 f. o. b. Cincinnati. Complete transmitter less motor-generator, $285.00.

Equipment so designed that either voice, buzzer modulated C. W. or straight C. W. transmission may be used by throwing single switch on panel. Construction of apparatus and material employed is of usual "ACE" quality.

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Who's Who in Radio

(*Continued from page* 530)

is the "grid" member, interposed across the path of the traveling ions ("wanderers," as their Greek name implies.) Dr. De Forest chose to deal then with "ions," gas atoms or sub-atoms—matter in its most tenuous form, what Prof. Crookes well styled the "fourth state of matter." Try to imagine one of these ionic carriers of the voice, or electric charges and contrast it with a carbon granule of a microfone transmitter of the early "telefonic relays." Compare a soap bubble with a load of coal, and you will have some relative idea of the difference between the delicacy and elegance of the Audion and that of the old microfone relay.

Transoceanic telefony by submarine cable, with numerous Pupin coils and the Audion Amplifier, is theoretically possible; commercially, an utter impossibility. The cost of such a cable would be prohibitive. But transoceanic wireless telefony is within reach. The De Forest Audion and Amplifier, extending, as they have, the range of wireless and making loud those signals which otherwise are inaudible, makes this result possible.

DE FOREST'S WORK REWARDED.

Dr. De Forest's work in wireless telegraphy was recognized by the St. Louis Exposition Jury of Awards in 1904 by the bestowal of a gold medal for his research work and discoveries along that line. He was also awarded a gold medal by the Panama Pacific International Exposition held at San Francisco in 1915 for the part his Audion Amplifier played in the transcontinental telefone service opening that year, as well as for the Oscillion and Audion Detector, which made possible the transoceanic radio telefone communication from Arlington to Honolulu and Paris in November, 1915. He is a member of the Yale Club, the American Institute of Electrical Engineers, the Institute of Radio Engineers, Franklin Institue of Philadelphia, and the Radio League of America. He is president of the De Forest Radio Telephone and Telegraph Company. He resides at 232nd Street and the Hudson River, and his laboratory is located at 1391 Sedgwick Avenue, in the factory of his company.

Club Gossip

(*Continued from page* 531)

club rooms, 2211 Bedford Ave., on Saturday, February 5. Tickets can be purchased from J. Phillips, 312 Flatbush Ave., Brooklyn, or from any of the club members.

RADIO CLUB OF SAVANNAH

The reorganization of the Radio Club of Savannah, Ga., took place October 13, 1920, and the following officers were elected: President, T. W. Hughes; vice-president, B. Rockwell; secretary, A. R. Foy; treasurer, F. E. Johnston; sergeant-at-arms, R. R. Brewin.

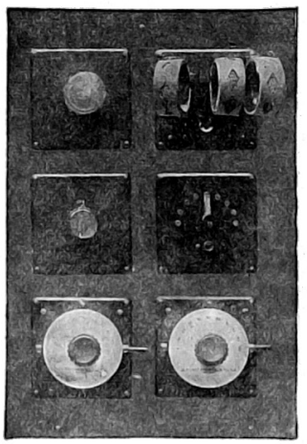
The purposes of the club are to avoid interference with government stations; keep amateur transmitting stations on a wave-length of 200 meters or less; get the radio amateurs in and around Savannah into closer fellowship with each other so that they may study radio telegraphy and telefony to a greater advantage. The club will be glad to communicate with anybody interested in radio work in this section of the country. Address Albert R. Foy, Secretary, 5 40th St., East Savannah.

BAY COUNTIES' RADIO CLUB

The Bay Counties' Radio Club of Oakland, Cal., was organized in the spring of 1920 and now claims to have the largest membership of any radio club of its kind, boasting of over 200 active members and new members coming in strong every meeting night.

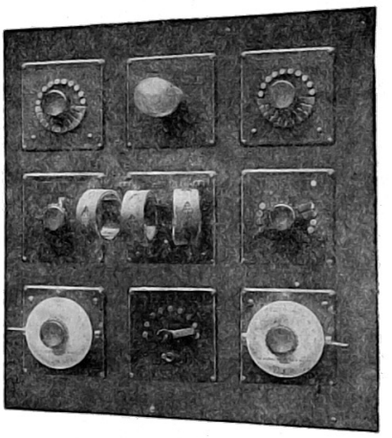
The purpose of the club is to organize the amateurs of the city and thereby control the QRM question. This has been successful to a markt degree.

Newest Ideas in De Forest Unit System Receiving Apparatus



Six Panel Unit Set

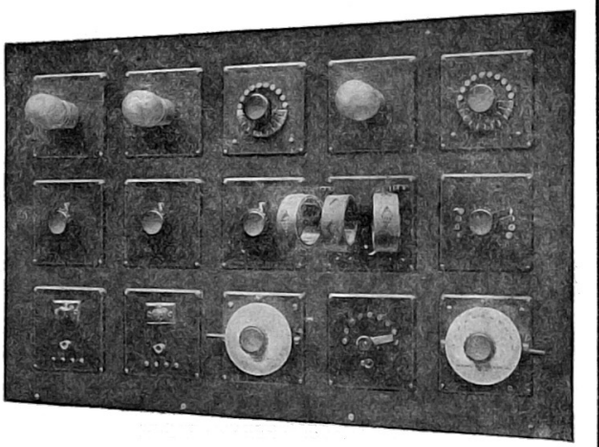
Comprising a combined Tuner and Detector to receive all local stations and practically any large station in the world. Everything necessary for the operation of the set, *including detector tube, "B" battery, head phones and a set of 11 coils*, can be had for $75.00 complete. (Purchaser to furnish panel board and "A" battery.) This set will give greater satisfaction than any outfit at anywhere near this price. Expansion possibilities unlimited.



Nine Panel Unit Set

Comprising the same six panels shown above, and either three additional panels to give one step of amplification, or three panels to increase the efficiency of the original six. The former will add about $23.70 to the cost of the original six; the latter about $12.10.

ADVANTAGES of the Unit System include extreme economy due to the simplicity and interchangeability of the units; convenience in arranging circuits to the individual need; and greater operating efficiency due to the engineering design and quality of the instruments. The Unit Sets shown here are a few examples.



Fifteen Panel Unit Set

Comprising the original six panels, with either of the additional three panels included in the Nine Panel Set, and also two additional steps of amplification. Thus for a total of about $134.50, or $146.10, a full Fifteen Panel Set that will outdo any other receiving apparatus may be had.

DE FOREST RADIO TEL. AND TEL. CO.

Manufacturers and Inventors of High-Grade Radio Apparatus
1415 Sedgwick Avenue, New York, N. Y.
LEE DE FOREST, Inc., Western Distributors
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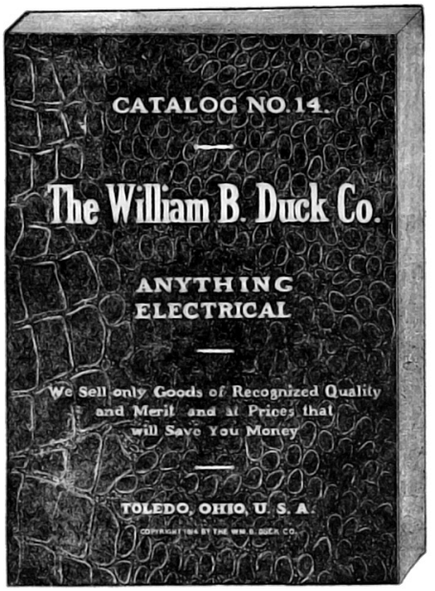
DUCK'S No. 14 Big 200 Page Wireless Catalog

A Veritable Treasure House of Everything Worth While and Dependable in Radio. The largest, most comprehensive, artistic and educational wireless catalog published. The Beacon Light to guide you right in the selection of your radio purchases, and at prices that will command your attention. Every instrument guaranteed with privilege of return if not satisfied.

Mail 12 cents

in stamps or coin (not sent otherwise), which amount you are privileged to deduct on first dollar purchase. Revised price list to first edition of catalog, with prevailing prices, mailed on request.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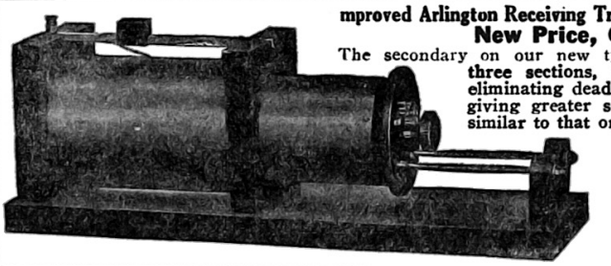
ANYTHING ELECTRICAL
We Sell only Goods of Recognized Quality and Merit and at Prices that will Save You Money
TOLEDO, OHIO, U. S. A.

Announcing Permanent Reductions on 3 of our most popular Radio Instrument

The demand last month for our Navy Type, Arlington, and No. 7721 Receiving Transformers at the greatly reduced prices convinced us that with large quantity production, because of the exceedingly attractive prices on these instruments, we can continue to maintain these low prices. We therefore announce the following permanent reductions on these instruments.

Model 5BB Navy Type Receiving Transformer, Former Price $27.50. New Price $21.95
No. 1091 Improved Type Arlington Receiving Transformer, Regular Price $15.00. New Price $11.95
No. 7721 Receiving Transformer, Regular Price $9.00. New Price $7.50

Send your order immediately for your choice of these popular instruments.



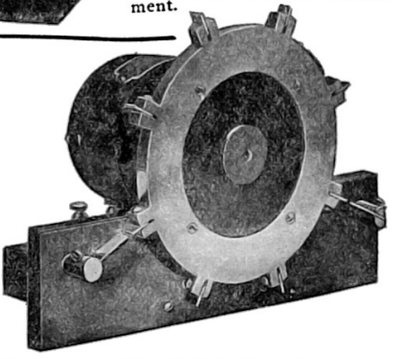
mproved Arlington Receiving Transformer, Regular Price $15.00
New Price, Only $11.95

The secondary on our new type Arlington is divided into three sections, with two dead end switches, eliminating dead end effect and harmonics and giving greater selectivity. The end support is similar to that on our Navy, permitting a looser coupling. The base and primary end pieces have a spline to prevent warping or damage in transit. This feature is also on our Navy. It is a beautifully finished instrument.

Improved Type Sayville Rotary Gap

Embodies the latest and best features in Spark Gap Construction

Our New Type Sayville Rotary Gap is, we believe, far in advance of any rotary gap on the market within a range even of twice the price. It is the final development of many different types made in our experimental Radio Laboratory. It fulfills every requirement of the ideal rotary gap. It is neat and attractive in appearance; simple and durable in construction; possesses a wonderful motor; has a cast aluminum rotary wheel, beautifully polished; every part is in perfect alignment; there is no wobbling of the rotor; produces and maintains a clear and pure 500-cycle note; is instantaneous in action; permits of no dragging of the spark; has contacts of tempered flat copper of proper length and width, easily and quickly removable, and inexpensively renewable; the stationary contacts are adjustable to any length.—**$27.50**



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THE only thing we know of, more complete than our radio stocks, is our new 84-page catalogue, now out. It lists every worth-while make of radio goods, every new development in the radio field, every instrument that you could possibly want. And in addition to this advantage, the prices clearly reflect the savings of low rent and expense. Send for your copy of this new catalogue today. Tomorrow may be too late. Please enclose 10c. to cover cost of mailing, etc.

Anything in the line of Aluminum VT Sockets, Radiotrons and Audiotrons, etc.

Special Offer: A fine lot of brand new, unused variometers at big savings. Prices, $4.50, $6.00, $7.00 and $9.00.

D. C. Voltmeters, 500 to 600 volts, $14.00.

American Electro Technical Appliance Co.
235 Fulton St. Dept. E. New York

MASTER WIRELESS APPARATUS MADE RIGHT PRICED

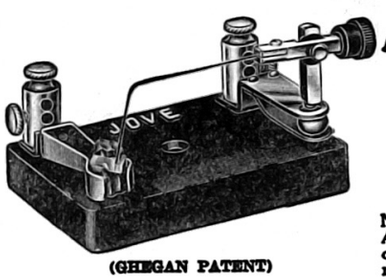
The Apparatus Supreme. Designed by Leading Radio Engineers, made by Expert Electricians, in a REAL Factory, at prices that are within the reach of ALL, while our SERVICE is the BEST in the Country on all Apparatus. The Monthly Bulletins will save you money.

A Catalog That is Different

Its a wonderful book for the REAL Experimenter, full of photographs, bargains and surprises and shows a complete line of WIRELESS INSTRUMENTS, SCIENTIFIC APPARATUS, CHEMICALS, LABORATORIES, GLASSWARE, Etc. Edition Limited. Send 12 cents (refunded on $1.50 order) for YOUR copy TO-DAY. We handle a complete line of Apparatus made by the leading Manufacturers. Service, Quality and Satisfaction or your money back.

PALMERS ELECTRICAL EQUIPMENT CO.
Palmers, Minn.

We Pay All Shipping Charges. We Are As Near As Your Mail Box.



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Bunnell INSTRUMENTS Always Reliable

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Handiest, Handsomest, Best
Sample by Mail, $2.00
Tested Galena Crystal, 25c

We are distributors of the Standard Electric Novelty Co.'s Type B "Cyclone" Audion Batteries. Also of De Forest and all the leading manufacturers of High Class Wireless Apparatus. Send stamp for new edition 42RN Catalog.

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HAVE YOU SOMETHING TO SELL OR EXCHANGE?
A classified ad in Radio News will reach 40,000 at a cost of only cents a word.

The new "bugs" are given help and advice by the "old-timers" and L. D. hours are highly respected by them. Good talks on radio are provided for at every meeting.

The headquarters is at the Alden library club rooms in Oakland. Every one is invited to attend the lectures given Friday evenings at 8 o'clock.

The officers of the club are: President, B. F. McNamee; first vice-president, George V. Tudhope; second vice-president, C. H. Grubbs; third vice-president, Mr. Hudd; recording secretary, Mr. Carroll; financial secretary, Mr. Wood; treasurer, Mr. Peterson; trustees, George V. Tudhope, B. F. McNamee, A. C. Adams; chief operator, Mr. Cornell; sergeant-at-arms, Mr. Sollie.

Corespondence is invited from eastern clubs.

(*Continued on Page* 578.)

The Arc or Continuous Wave Transmitter

(*Continued from page* 521)

audible, especially if the grooved wheel type of *tikker* is used. This consists of a small high speed motor driving a hard rubber pulley, the periphery of which has a steel time which is grooved. Secured to an insulating base and resting over into the pulley groove is a small steel wire. When the motor is driven at high speed, the groove being so very smooth *the centrifugal force throws the wire off from the surface of the wheel at a tremendous frequency.* This motor chopper being inserted in the receiving circuit breaks up the incoming undampt oscillations and brings them within the audibility of the human ear. A long wave antenna is especially efficient for receiving long wave spark stations also. Amateurs in the city can try this out by raising a box kite and using small hard drawn copper wire in the lower portion of the kite string. Of course, you must be very careful not to pay out too much wire and let the kite fall across the *trolley feeders.*

An Undampt Wave Method of Determining Dielectric Constants of Liquids

(*Continued from page* 522)

ordinary range of C_3, the condenser C_2 is inserted in series with C_x.

Preliminary measurements for a number of liquids give the following results for a wave-length of approximately 5,000 meters, and a temperature of 21° C.

Substance	Diel. Const.
Kerosene	2.12
Toluol	2.39
Ether (abs. ethyl)	4.32
Olive oil	3.11
(a good commercial grade)	
Petrol ether	1.86
(boiling point 50-60° C.)	

The readings are accurate to about 1 per cent. Further refinements in determining condenser settings will increase the accuracy of the results. The method is easy and rapid of manipulation, and its accuracy can be increased to any desired extent by using variable condensers of sufficient accuracy.

Abstract of a paper presented at the St. Louis meeting of the American Physical Society, December 30, 1919.

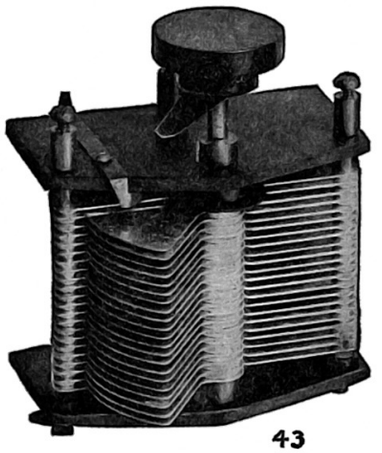
Help, Police!

Hem: Did you hear about the holdup on Sam's roof?

Haw: What was it?

Hem: Two poles held up his aerial.

W. DITZENBERGER.



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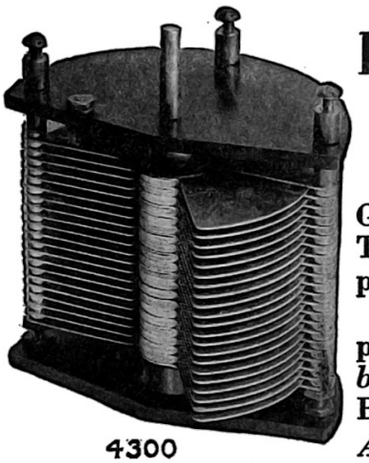


4300

Entire Satisfaction

is what our customers say.

ARE YOU

GETTING ENTIRE SATISFACTION from condensers you have purchased elsewhere?

IF NOT, we are sure you will be pleased with what we are offering, *because,* we manufacture *only* the BEST.

All we ask is GIVE US A TRIAL.

This month we wish to announce a NEW MODEL of VARIABLE CONDENSER, which will be known as SERIES "T". It is of the same general construction as our SERIES "S" condenser, but is built of heavier material, the aluminum plates being die stamped from 1/32" hard rolled stock. The spacers are also of heavier stock, and the general assembly insures a very rigid instrument. At the present time we are unable to fill orders for the SERIES "S" condenser, as we cannot obtain materials, but can ship the NEW SERIES "T" or the SERIES "L" condenser from stock.

PRICES

SERIES "T".

No. 20	2	plate	Vernier.	$2.00
No. 70	7	plate,	approx. .0001 m.f.	$2.35
No. 130	13	"	" .0002 m.f.	$2.75
No. 170	17	"	" .0003 m.f.	$3.15
No. 230	23	"	" .0005 m.f.	$3.60
No. 310	31	"	" .0007 m.f.	$4.30
No. 430	43	"	" .001 m.f.	$5.25
No. 630	63	"	" .0015 m.f.	$7.50

Include postage for one pound to your city.

SERIES "L".

No. 2300	23	plate, .00075	$6.00
No. 4300	43	plate, .0013	$8.00
No. 6300	63	plate, .002	$10.00

Include postage for two pounds.

Prices include knob and pointer and mounting screws. Specify whether brass or nickel pointer and screws, and thickness of your panel.

Either style of condenser, fitted with indicating dial at additional cost of 75c.

THE WIRELESS SHOP

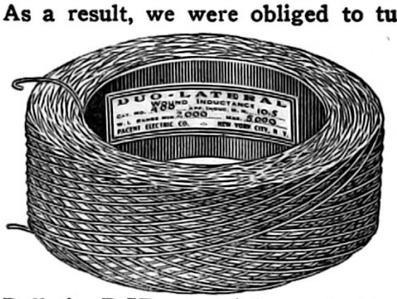
511 West Washington St. A. J. EDGCOMB Los Angeles, Cal.

Your Duo-Lateral Wound Coils Are Ready

"SERVIMUS"

JUST a word of explanation: **Our first advertisement caused such an upheaval in radio circles that we were swamped with inquiries. Indeed, one large manufacturer of radio apparatus immediately placed his contract with us, taking over our entire output. As a result, we were obliged to turn down orders.**

THAT was up till a short while ago. Now we have succeeded in doubling our productive capacity, and Duo-Lateral Coils are available to everyone in the radio field. We can make prompt shipments from stock. ***Your DUO-LATERAL COILS are ready to to be shipped the moment your order is received***



REMEMBER: DUO-LATERAL COILS are recognized for:

1. Lower natural period.
2. Lower high-frequency resistance.
3. Very low distributed capacity.
4. Lower direct current resistance.
5. Higher self-inductance.
6. Mechanically stronger.

Bulletin P-IR, containing valuable engineering data, constants and prices of numerous sizes of Duo-Lateral Coils, covering practically every wave-length used, is yours for the asking.

TO DEALERS: OUR DISCOUNTS ARE GENEROUS

PACENT ELECTRIC COMPANY, Inc.

LOUIS GERARD PACENT, President

We now represent the WIRELESS IMPROVEMENT CO. excusively

Representing: A. H. Grebe & Co., Dubilier Condenser Co., Electrical Products Mfg. Co., Richter-Schottler Co., H. W. Sullivan of London, Rawson Elec. Inst. Co., and others.

150 NASSAU STREET **Telephone Beekman 5810** **NEW YORK CITY**

The CHICAGO RADIO LABORATORY *Announce*

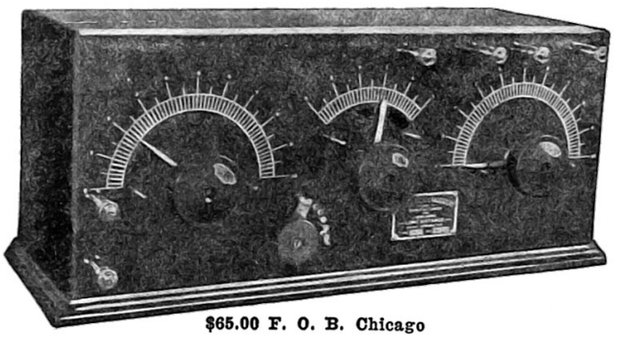
THAT the products of this company will hereafter be known, advertised and distributed as the "Z-NITH" apparatus, the mark of highest success.

The broadening field that has been opened up through the perfection of these products and through the adoption of more intensive methods of merchandising make the establishment of this name necessary.

The most popular and widely known of these products, the C. R. L. Paragon Short Wave Regenerative Receiver, will now be known as the

"Z-NITH"

REGENERATOR



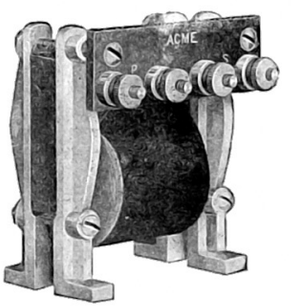
$65.00 F. O. B. Chicago

There is a **Z-NITH** product for your every need. Our Engineering Department has been built up by years of effort and embodies a wealth of knowledge and experience in the design and production of special apparatus and installations.

THE CHICAGO RADIO LABORATORY CHICAGO

Offices: **1316 Carmen Avenue** ***Testing Station:*** **9ZN—5525 Sheridan Rd.**

ACME AMPLIFYING TRANSFORMER

$5.00  **$5.00**

INCREASED IMPEDANCE RATIO

We have found that a gain in efficiency may be obtained by increasing the impedance ratio of our Amplifying Transformer, especially on the new tubes. Our latest transformers have this increased ratio.

CARRIED IN STOCK BY LEADING DEALERS

ACME APPARATUS COMPANY, 25 Windsor St., Cambridge 39, Mass.

UP-TO-DATE TRANSFORMER AND RADIO ENGINEERS AND MANUFACTURERS

IMPORTANT ECONOMY RADIO SPECIALS FOR FEBRUARY

PLATE BATTERIES—The brass strip soldered, brass strip terminal kind. Terminals drilled for bolt and nut connections. No wires to break or corrode. Large sized, long lived 4½ volt flashlight batteries, the best obtainable, soldered together forming units that are hard to beat and harder to kill.

ERSCO NO. 503 PLATE BATTERY, 22½ volts, adjustable, price $2. ERSCO NO. 803 PLATE BATTERY, 36 volts, adjustable, price $3.20. We have sold many hundreds of our batteries in our own home city and every customer is now a booster.

PANELS—Are you building your own set? Our panels are what you are looking for. Black fibre panels ¼ in. thick, easy to work with and take a nice finish.

The No. 1 panel is 7 x 20 x ¼ inches, just the right size for a Paragon, price $3.00.

PANELS CUT TO MEET YOUR INDIVIDUAL REQUIREMENTS, PRICE 2½ CENTS PER SQUARE INCH. ALL EDGES MACHINE CUT AND ABSOLUTELY SQUARE. WE SHIP PARCEL POST PAID ANYWHERE IN THE UNITED STATES

Mail orders should be accompanied by remittance. Reference Merchants and Manufacturers National Bank, Newark, N. J.

ECONOMY RADIO SUPPLIES CO., 232 Sanford St., EAST ORANGE, N. J.

A 15 MILE RADIOPHONE OPERATING ON "B" BATTERIES

Out of a large stock of genuine double filament, double life AudioTrons, we have carefully selected and tested a limited number of tubes which are especially adapted to be incorporated in Mr. H. D. Selvage's 15-mile radiophone operating on "B" batteries. His circuits, together with directions for assembling, advertised elsewhere in this magazine, has been thoroughly tried and proven by a large number of amateurs who are now talking over remarkable distances.

We are offering you an excellent bargain by cutting the price of thees specially selected genuine double filament AudioTrons from $6 to $5 each.

Results are positively guaranteed when our tubes are used in connection with Mr. H. D. Selvage's radiophone circuit.

The Kehler Radio Laboratories, 901 W. 1st St., Abilene, Kansas

Bound Volume No. 1, Radio Amateur News, 12 issues, July, 1919—June, 1920. Attractively Bound. Only $2.00 plus postage for 8 lbs. A most valuable asset to your library. Order today.

A Detector and Three-Stage Amplifier for Fifty Dollars

(*Continued from page* 512)

handsome appearing instrument, altho it requires great care in drilling, not to break thru the front surface. Because of this fact it would be better to use a ⅜" panel rather than ¼", but ¼" was used in this case.

The only holes drilled thru are for the four rheostat shafts, four telefone jacks, eight binding posts, and twenty-eight ventilating holes with a ventilating area of 2.15 sq. in. equivalent to a single hole nearly 1½" square. The only adjustments are by the four rheostat knobs controlling the filaments of the four tubes.

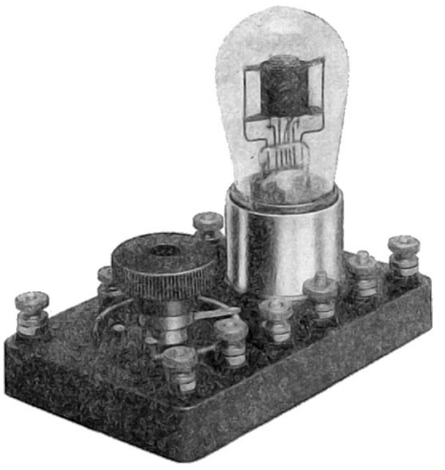
The four binding posts at the left, Fig. 1, as indicated by the engraved letters, reading from the top down, are, grid condenser and leak, negative side of filaments, detector plate, and plate jack. Those at the right, reading down, are, positive side of filament rheostats, negative side of filaments, and one side of telefone jacks. Three of the eight binding posts are thus connected to the negative side of the filaments. The four binding posts at the left go to the tuner secondary and tickler; those at the right go to the storage battery and plate battery, tho there is room for a plate battery in the cabinet. All the tubes use the same filament and plate battery, tho the filaments have individually adjustable rheostats—the only adjustment to be made in operation, and even this adjustment may be left fixt after being once regulated. Individual tube filaments are turned off by turning the rheostats to the "off" position. The rheostat knobs showing on the front of the panel, Fig. 1, are for the detector, first, second, and third stage amplifier, respectively.

The first step in assembling the complete instrument is to drill the panel from the front. The binding posts are all mounted with their centers ⅞" from the edge and 1¼" center to center. The four rheostats are located half way between the top and bottom of the panel, that is, 4½" from top or bottom. The end rheostats are centered 2" from the edge, and the others are spaced uniformly between these, 2½" from center to center.

Like the binding posts, the four telefone jacks are centered ⅞" from the bottom edge of the panel, and are placed symmetrically with the rheostats, and directly under them; that is, the end jacks are centered 2" from the edge of the panel, and the other two are uniformly spaced between these, with 2½" between centers.

The holes above the rheostats give the necessary ventilation, as before mentioned, and also serve as windows thru which the brightness of the filaments may be observed. The center hole in each group is symmetrical with both the telefone jacks and the rheostats, being directly above them; the first and last center holes at left and right are centered 2" from the edge of the panel, and the other two are uniformly spaced between these, with 2½" between centers.

The holes above the rheostats give the necessary ventilation, as before mentioned, and also serve as windows thru which the brightness of the filaments may be observed. The center hole in each group is symmetrical with both the telefone jacks and the rheostats, being directly above them; the first and last center holes at left and right are centered 2" from the ends of the panel, and the other two center holes between these have 2½" between centers.



A VACUUM TUBE OUTFIT

SIMPLE, EFFICIENT—YET INEXPENSIVE

The illustration at the left shows the new Radiotron U.V. 200 vacuum tube and the A.M. "Paragon" Detector Unit—complete with tube socket, grid leak, condenser, rheostat, etc., all molded in a solid Bakelite composition base.

Price, as shown
Postage
10 cents

$11.00

With "B" Battery $13.65
Radiotron U V 200 5.00
Paragon Detector Unit 6.00

TWO SUGGESTED RECEIVING OUTFITS

VACUUM TUBE SET

1 Murdock Receiving Transformer.....$9.00
1 No. 1 Chelsea Condenser, .001 m.f..... 5.00
1 No. 2 Chelsea Condenser, .0005 m.f..... 4.50
1 A.M. Paragon Detector Unit..... 6.00
1 Radiotron U.V. 200 Vacuum Tube..... 5.00
1 Block 22.5V. "B" Battery..... 2.65
1 No. 55 2000 ohm Tel. Head Set..... 4.50

Request Bulletin 14

CRYSTAL DETECTOR SET

1 Murdock Receiving Transformer.....$9.00
1 No. 1 Chelsea Condenser, .001 m.f..... 5.00
1 No. 2 Chelsea Condenser, .0005 m.f..... 4.50
1 A.M. Crystal Detector 1.75
1 No. 55 2000 ohm Tel. Head Set..... 4.50

ATLANTIC RADIO CO.
INCORPORATED

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Branch: 15 Temple St., Portland, Me.

Here's a *Sure* Winner—

For long distance work you can find nothing to beat the

GREBE RADIO

Type CR-3A
Short-Wave Regenerative Receiver and Vacuum Tube Unit

Compact, complete, dependable, with a wave-length range running up to 375 meters, if fills the need for a moderate-priced regenerative receiver. Built in every way up to the Grebe standard.

The CR-3A includes a variable antenna circuit, continuously variable grid and plate circuits, a specially designed coupling circuit and a standard vacuum-tube mounting with a grid condenser and leakage element. All binding posts are conveniently located on the front of the panel. The price $45.50 is within the reach of all.

Be sure to ask your dealer about the CR-3A.

GREBE RADIO apparatus is licensed under the original Armstrong and Marconi patents.

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Hurlburt Still Electrical Co., Houston, Texas
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U. of I. Supply Store, Champaign, Ill.
Klaus Radio Company, Eureka, Ill.
Manhattan Electrical Supply Co., New York, Chicago, St. Louis.
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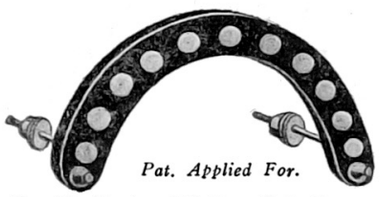

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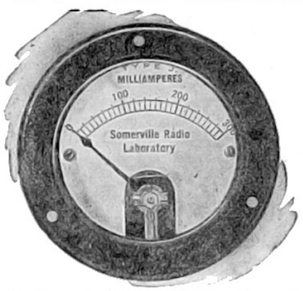

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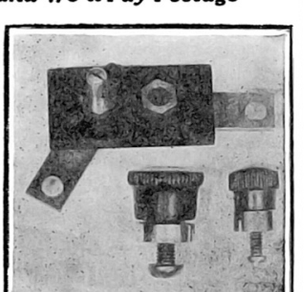

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The arms may be fitted to any pair of binding posts, as they are adjustable. Used on variable condensers with DeForest coils to make wave meters, radio frequency amplifiers, tuning units, etc. Also as mounting plugs on Coto Coils.

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We pay postage on 90% of our shipments. Just try Sorala quality, price and service, which includes all apparatus of standard makes.

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Paragon RA-10	85.00
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Radiotron UV-200	5.00
G-R "A" Bat. Potentiometer	4.00

350 Ohms, for Plate Voltage Control on Radiotrons.

SOMERVILLE RADIO LABORATORY, 102 Heath St., Somerville, 45, Mass.

This line of holes is 2¼" from the top and 2¼" above the line of rheostats, being thus half way between the rheostats and the edge of the panel. Around each center hole is drilled a circle of six similar holes on a radius of 1" from the center. For all these window holes a $\frac{5}{16}$" drill was used.

The four corner holes for securing the panel in the cabinet were made with a ⅛" drill, and countersunk to take the half-round heads of the screws mentioned in the list of material. They are centered ¼" from the end edges of the panel, the upper holes being 1" from the top edge of the panel, and the bottom holes 1" from the bottom edge.

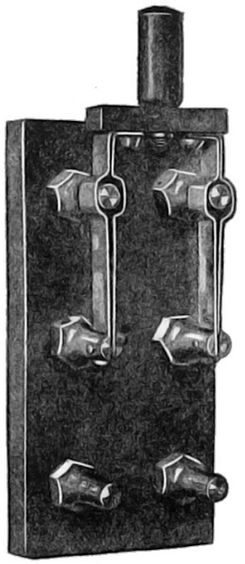
This symmetrical mounting of parts, as well as the freedom of the front of the panel from screw heads, gives the instrument a very neat and beautiful appearance, simple and workmanlike. An additional advantage of this particular spacing is the greater ease and simplicity of wiring at the back. The binding posts are engraved with identifying letters, the jacks with Roman numerals, and the rheostats with circular arrows and the word "OFF," as is clearly seen in the photograph, Fig. 1.

Before drilling the panel the location of all holes should be laid out on a sheet of paper the exact size of the panel. The paper is laid on the panel after the graining is finisht, and the center of each hole prickt thru the paper into the face of the panel with a center punch. Furthermore, after the front of the panel is completed as to graining and drilling, it should be protected from scratching by a covering of paper made larger than the panel so that it can be folded over all the edges and temporarily secured on the *back* side with glue or shellac, and should not be removed until all the work on the back of the panel and all the mounting of parts on the back, even the wiring has been done. One careless scratch will ruin the appearance of this very fine instrument, and no precaution should be neglected to secure its freedom from blemishes.

Turning now to the back of the panel, as shown in Fig. 2, it will be noted that with the exception of the single wire from the positive filament ("A") battery binding post to one side of all the filament rheostats, no wiring appears on the upper half of the panel. The four tube sockets are mounted on a shelf which divides the panel into two parts, in the upper one of which appear only the rheostats, tubes, and sockets, and in the lower one of which are mounted the three amplifier transformers, the four telefone jacks, the grid and bridging condensers and grid leak, and the necessary wiring. The only concealed parts are the grid polarizing resistances inside the bases of the tube sockets, which will be noted later.

The shelf is 3½" wide by 10" long, of ⅛" Formica, and is fastened to the back of the panel with small machine screws holding small brass angles made of sheet brass ½" wide, 2½" long, and $\frac{1}{16}$" thick, bent at a right angle 1¼" from one end, and drilled for the four round head machine screws, as shown in the illustration. As the shelf is 10" long, 2" shorter than the panel, a space of 1" is left between each end of the shelf and the adjacent edge of the panel, so that the whole panel, with mounted apparatus, will slip into the cabinet as a complete unit. The shelf is so placed that the bottom edge of it is 3" above the bottom edge of the panel, a position which will bring the tip of a Marconi V.T. 2" from the top of the panel, and thus clear the inside of the cabinet by about 1¾" if the cabinet is made of ½" stock, like the present one.

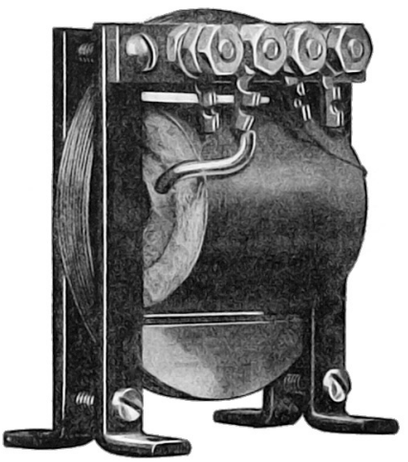
The three transformers are centered between and above the line of jacks underneath the shelf, but fastened to the panel, with the terminals marked "P_1 S_1" down,



(Illustration exact full size)

Z. R. S. Miniature knife switch is supplied unmounted only, for panel mounting and will harmonize with other fine products of the instrument maker. There is nothing else like it on the market.

Double pole, single throw - - - - 80c
Double pole, double throw - - - - 90c



Modulation transformer - - - - $4.50
Choke coil .8 Henry - - - - - $3.75
Amplifying transformer - - - - $4.00

All these are mounted as shown in the illustration and will give you results second to none.

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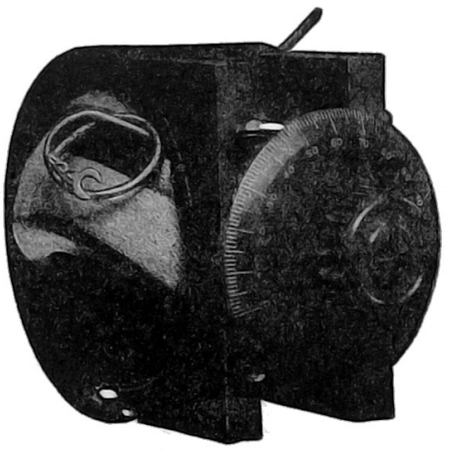

Type Z.R.V. Variometer has unit construction with bakelite shell and hard wood ball. Has low dielectric losses and a range of inductance of 1.25 mil henry maximum to .1 mil henry minimum. Is readily used on table or mounted on panels.

Complete with 3" dial and knob - $6.50
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RADIOTRON U.V.201 is an unexcelled amplifier of the Pliotron type designed for detection and for radio and audio frequency amplification. Normal plate voltage, 40 (two standard B batteries). Plate voltages up to 100 may be used with increased amplification. Amplification constant 6.5 to 8 at 40 volts, 8 to 10 at 100 volts. Impedance 15,000 to 25,000 ohms at 40 volts on the plate, 10,000 to 15,000 ohms at 100 volts on the plate.

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All Radiotron tubes mounted with 4 prong bases and instruction booklet sent with each tube.

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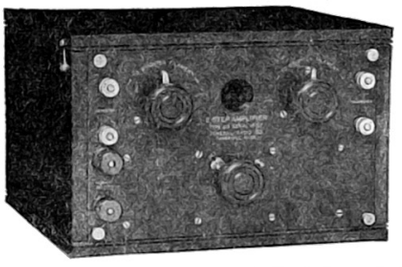

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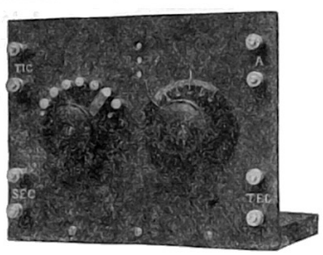
Grid condenser and leak mounted in back of panel and so wired that it can be adapted to any modern hook-up.



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and the terminals marked "P_2 S_2" uppermost, next to the shelf, to make the wiring as neat as possible. In this position the transformers are 1¼" wide, measured horizontally.

The four tube sockets, which are 2¼" square, are mounted along the back edge of the shelf, the end sockets being flush with the shelf ends, and far enough from the panel to give good clearance to the moving contacts of the rheostats. This position leaves ⅜" between socket bases. As shown in the photograph, Fig. 2, the sockets are placed with the plate and grid side toward the back, away from the panel, and with the filament side next to the panel. The positive filament terminals of the sockets are all connected to one wire running beneath the shelf, and each individual negative filament terminal goes to one side of its individual rheostat, the other side of all rheostats going to the common wire running above the shelf, as already mentioned. Inserted between each negative filament terminal and its rheostat, however, is a short length of resistance wire having a resistance of 1 ohm, coiled inside the socket base of each tube, for the purpose of giving the proper negative potential to the grids. The contact screws in the sockets are run down thru holes drilled in the shelf, as small machine bolts with nuts (shown in photograph, Fig. 2), and these serve as securing screws and also leave the space above the shelf free of connecting wires.

The four jacks, connected on one side to the individual plates and on the other side to a common wire leading to a binding post, with back connections to the transformer primaries (see Fig. 3) allow the telefones to be plugged into the detector plate circuit with no amplification, for strong signals, or into the plate circuit of any amplifier, thus permitting any desired degree of amplification for weak signals, and at the same time cut out all the transformer and tube circuits not in use. It is suggested that the plug for the telefones be connected not directly to the telefones, but by a short cord to a terminal block screwed low down on the outside of the cabinet at the end away from the tuner, to which block any number of pairs of telefones may be connected without interfering with the plug.

The small copper foil and mica fixt condensers, the construction of which has already been explained in another article,* are of .002 mfd. for bridging the negative filament and common plate jack binding posts, and of .0002 mfd. for the grid. These, with the 2 megohm grid leak, are mounted under the detector end of the shelf, adjacent to the binding posts leading to the tuner. This is the left end looking at the front of the panel (Fig. 1), and the right end looking at the rear (Fig. 2). The condensers and leak show plainly in the photograph of Fig. 2. In the latter figure the tubes, from right to left, are, detector, first stage amplifier, second stage amplifier, and third stage amplifier; the rheostats, transformers, and jacks correspond to this arrangement, as noted in connection with Fig. 1.

All connections are soldered, and all wiring is done with No. 10 bare copper wire run as directly and neatly as possible. The ingenious arrangement of all the parts makes the leads all short and direct, and the wiring extremely simple.

The diagram of connections is shown in Fig. 3, and without special comment will be readily understood from the photographs and from the data already given. The lettering and numbering on the diagram are the same as those on the front of the panel. In wiring, to show the connections looking at the rear of the panel this dia-

**See Elliott A. White, "The Simplest Long Wave Receiver," in Science and Invention for October and November, 1920.*

—always remember

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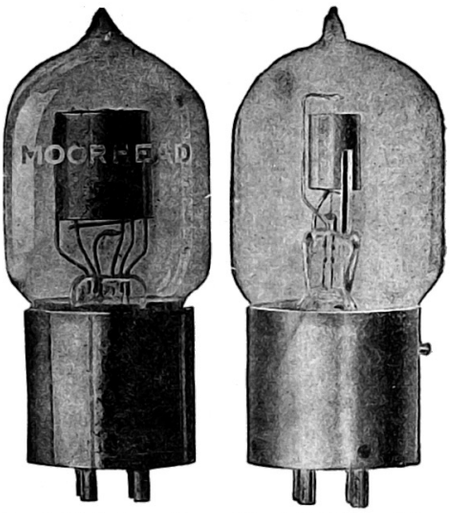

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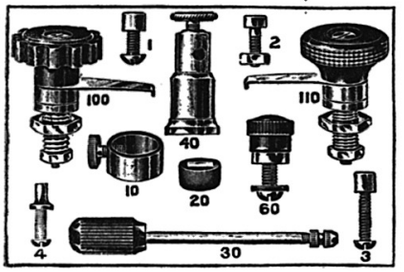

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All switch points are furnished in polished nickel.

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3	Switch point 7/32 x 7/32 inch head with 4-36 screw	.05
4	Switch stop 3/8 inch high with 4-36 screw	.06
5	Switch point 3/16 x 3/16 inch head with brass screw	.04
6	Switch point 1/4 x 1/4 inch head with brass screw	.05

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These parts are furnished in polished nickel, and may be combined to form a fine detector for panel use, or for mounting on a base.

10	Detector Cup 5/8 inch in diameter with knurled set screw for fastening crystal	.35
20	Crystal, very sensitive, tested galena, mounted in Woods metal	.40
30	Detector rod, equipped with chuck allowing the use of any size cat-whisker	.35
40	Detector standard, for use with No. 30 detector rod	.35

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60	Binding post, polished nickel, with hard rubber top	.12
100	Switch lever, heavily knurled bakelite knob, furnished with bushing, ready to mount on panel, all metal parts are nickel plated and polished	.60
110	Switch lever, same as No. 100, but furnished with finely knurled knob as shown in cut	.60
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gram may be looked at reflected in a mirror; or looked thru from the opposite side of the page by being held to the light; or traced over by putting a sheet of paper under the page, and under that a piece of carbon paper *face up*. The tracing will then show the reverse of Fig. 3. (This method is always useful in getting the reverse side of the drawing of a wired panel.)

It will be noted that as all the apparata is fastened to the panel, and as all connections to the instrument are made by binding posts on the front, everything may be removed for inspection or for renewal of tubes, merely by undoing the four wood screws and slipping the panel out of the cabinet. A further suggestion is that the panel be *hinged* to the cabinet at one end by brass pin hinges, so that the panel may be merely swung out, or lifted off the hinges for complete removal. The hinge arrangement is very neat.

The cabinet, with dimensions of 9" x 12" x 4" to take this panel and attached apparata, was made especially for it, of natural finish oak, ½" stock, and was quite expensive. It could be built at home with much less expense, but was included for consistency in using thruout only parts that could be bot complete at retail.

The salient points about the instrument described are its neatness, compactness, fine finish, workmanlike construction, efficiency, and moderate price; to appreciate the effectiveness and cheapness of the set, it should be compared with similar apparata, say detector and only three stage amplifier, now on the market and costing considerably more. Furthermore, no one need hesitate at the construction of so simple a set, for the only work is to assemble parts already widely advertised and procurable anywhere.

Awards of $100 Radio Prize Contest

(*Continued from page* 514)

All the different parts are fixt on a fiber panel ¼" thick and the overall dimensions of the box containing the complete set are 5" x 3½" x 3".

This set also gives excellent results with a loop antenna of two or four turns of fine wire (Fig. 3), concealed inside of an overcoat and reception may be successfully practiced this way while walking in the street. A ground is not necessary as messages come in very clearly without, but one can be easily connected as the set has four binding posts—two for the fone, one for the aerial and one for the ground.

Controlling by Wireless

(*Continued from page* 523)

relay closes the circuit to the display apparatus. If the sending switch is still closed, when the arm again passes over the corresponding one at the receiver, more current passes thru the relay and it continues to stay closed. Thus any or all of the display apparatus is at instant control by this selective system.

In regard to this control there are many interesting and novel stunts that may be performed, and numerous machines and apparata operated with this outfit.

Battleships can be blown up by small submarines, camouflaged by waves of water cut from tin; toy street cars and locomotives can be operated thru mountains and tunnels, while light circuits, motors and numerous mechanical devices can be quite easily controlled.

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The reason for this preference is apparent. Exceptional sensitiveness combined with ruggedness gives BALDWIN PHONES their popularity. The diaphram is made of the finest quality selected mica with the force concentrated at the exact center as in high grade phonograph reproducers. This feature is highly important in the reception of radiophone music.

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Junior Radio Course

(Continued from page 538)

In practice, to avoid the production of unused oscillatory current during the time no signals are sent, the key is placed at such a point in the circuit that the V. T. oscillates only when the circuit is closed. In order to keep the wave-length constant, a condenser replaces the aerial, the latter being only coupled to the oscillatory circuit, Fig. 5.

We will explain, in the next lesson, how the V. T. oscillator is used in the regenerative circuit at the reception and as separate heterodyne.

Questions for this lesson:

1. Explain the use of the coils in the grid and plate circuit of a V. T. oscillator.

2. What happens in the circuits when the filament is lit up?

3. Where is the key connected in a C. W. transmitter and explain why it is best to make and break the circuit at a certain point?

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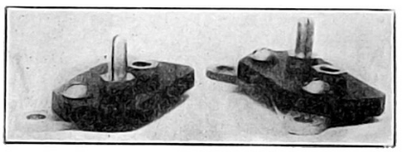

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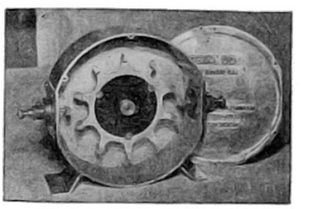

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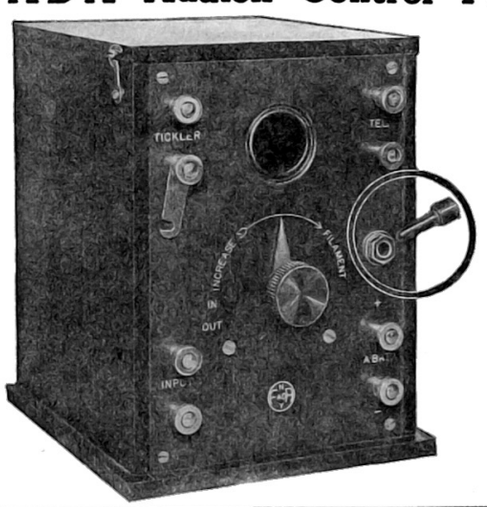

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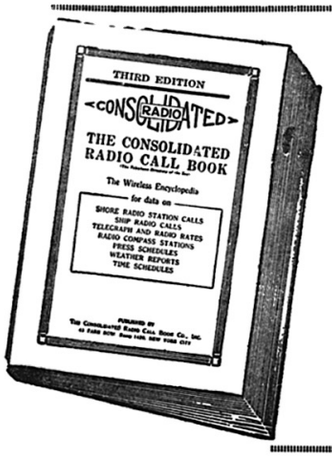

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Notes on Modulated Tube Transmitters

(*Continued from page* 525)

shown that very little is gained by making the choke coil reactance greater than twice the resistance of R_o and R_m in parallel. That is, the value of choke coil inductance may be determined from the formula

$$L = \frac{2\,R_o\,R_m}{R_o + R_m} \times \frac{1}{2\pi f}$$

$$= \frac{R_o\,R_m}{\pi f\,(R_o + R_m)}$$

It is not at all necessary, therefore, to make the choke coil as large as has been popularly supposed. In fact, increasing the coil reactance from twice the parallel resistance of oscillator and modulator to infinity only increases the modulation about ten per cent. The frequency used in the above formula for determining L should be the lowest that is apt to be encountered in talking. This is about 200 cycles. The current thru the choke coil will not be con-

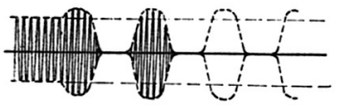


FIG. 6.

Curve Showing the Distortion Produced When Working With Under Excitation.

stant and indeed it is this very variation in current which produces the changes in voltage across the choke coil and causes modulation.

From considerations of space, weight, resistance and cost, the choke will practically always be of the iron core type. The design problem presented in this case is somewhat different from that of the ordinary iron core choke coil because of the fact that the winding always carries a direct current, this being the combined current to the oscillator and modulator. The magnetizing effect of this current tends to saturate the iron core reducing thereby its permeability and hence the inductance of the coil. The conditions encountered may be explained by reference to Fig. 12. This figure shows the normal B-H curve for the iron core and also the way in which the permeability varies with the magnetizing force. The direct current from the high voltage source in flowing thru the wind-

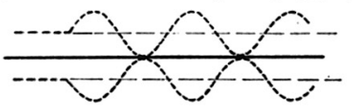
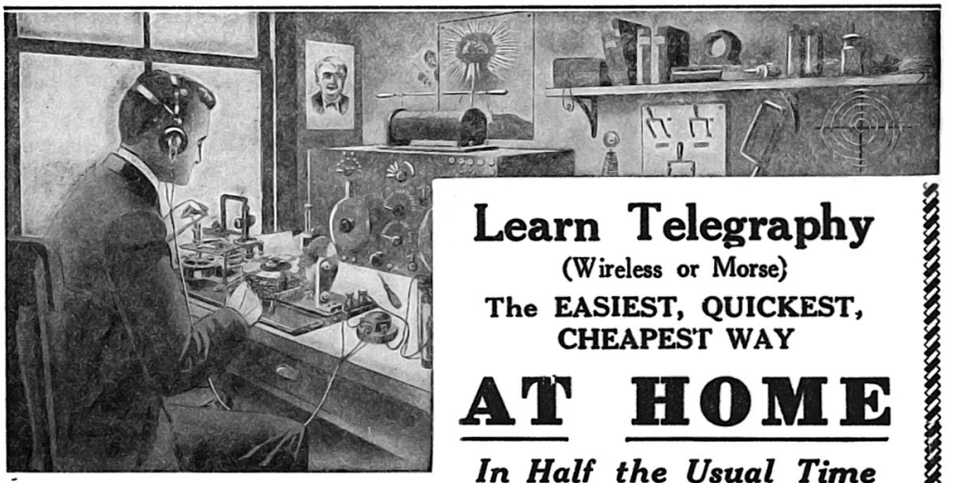


FIG. 7.

With a Proper Value of Excitation the Current is Completely Modulated.

ing of the coil, quickly saturates the core and the flux density reaches some such value as A on the curve. The permeability is then very low; it may in fact be nearly unity so that the iron is not at all effective and the inductance of the coil is not much greater than would exist were the iron entirely removed. The whole device becomes a choke in name only and the modulation qualities of the system are lost.

In order to prevent this effect an air gap must be cut in the magnetic circuit of the core. This flattens out the magnetization curve as shown in Fig. 13 and the permeability at the working magnetization is higher and more nearly constant for vary-



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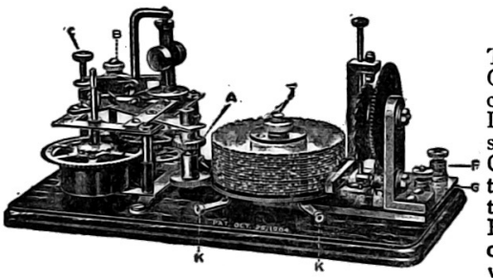

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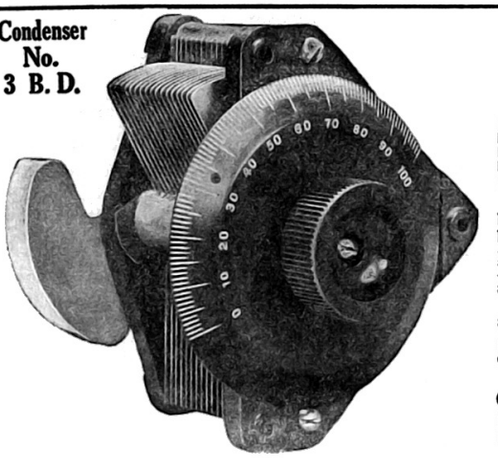

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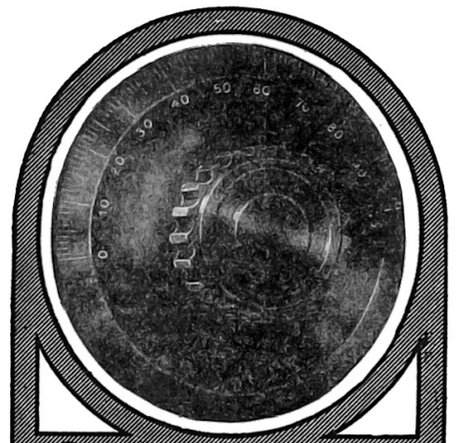

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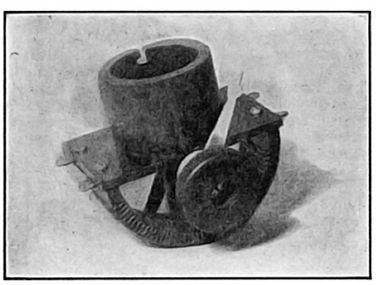

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ing currents. The proper length of air gap depends of course upon the inductance required, the direct current thru the winding to the oscillator and modulator plates, the characteristics of the iron in the core, and economic considerations in design. Low resistance is desirable in the winding in order not to cause too great a loss in voltage furnisht to the tubes.

LIMITATIONS OF TUBE AS MODULATOR

For the best functioning of a tube as modulator it is desirable that its internal plate resistance should drop to a low value when the grid goes a very small amount positive. This condition, however, is far from being met in most practical cases, especially where the same type of tube is used for modulator as for oscillator. Usually it is necessary to drive the grid to an extremely large positive value in order to sufficiently reduce the tube resistance to get maximum modulation. When the grid becomes positive a current flows from it to the filament inside the tube. This current must be supplied from the speech transformer stepping up from the microfone transmitter. Now the transformer must have a very high step-up ratio, in fact its

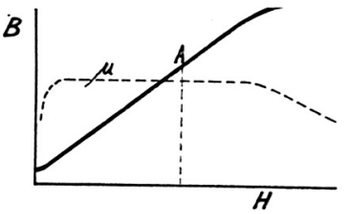

FIG. 13.

This Curve Shows How to Flatten the Magnetization of the Choke Coil Core by Cutting a Gap in the Latter.

secondary impedance will be in the neighborhood of several hundred thousand ohms. Even a very small grid current (which must of course pass thru the transformer secondary) will therefore cause considerable loss in the winding. The microfone itself can only supply a few hundredths of a watt of power on the loudest talk, so the result is that there may not be enough power available to drive the grid to the necessary positive potential to give complete modulation. With the type of tubes supplied in the amateur market, however, it is not hard to get 80 or 85 per cent. modulation when one oscillator and one modulator are used.

When the number of modulator tubes is increased, as is necessary when more oscillators are used, the power required to drive their grids is increased proportionally and for more than two tubes it is necessary to

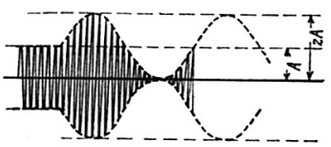

FIG. 15.

Curve of Perfect Modulation Showing the Variations in the Antenna Current.

use a speech amplifier between the microfone and the modulators in order to get good modulation amplitude. A circuit for this purpose is shown in Fig. 14.

A resistance R of several thousand ohms should be inserted in the plate circuit of the amplifier in order to reduce distortion and the ammeter at A will indicate whether or not distortion is present. Its reading will not change when talking into the microfone if there is no distortion.

BLOCKING

Certain types of tubes when used as modulators produce distorted speech as a result of what is known as blocking. This is due to secondary emission from the grid

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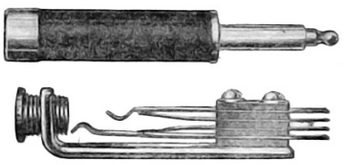

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and is most pronounced if the plate voltage on the tube is kept high when the grid goes positive. If the plate voltage is kept low the secondary emission is greatly reduced or even altogether absent. Now in the operation of the modulation system in practice, the plate voltage is never constant but in general falls when the speech voltages send the grid positive, and increases when the grid goes negative. If the plate voltage falls at the same instant that the grid goes positive, that is if the grid and plate voltages act in phase, then the likelihood of blocking will be much reduced because when the grid gets over into the dangerous positive region the plate voltage will be very low and there will be no secondary emission. If there is a phase difference between the grid and plate voltages then trouble may be expected because when the grid reaches its maximum positive value the plate voltage will still be relatively high.

Whether or not this phase difference exists to a serious extent depends upon the reactance of the constant current choke coil in relation to the internal resistance of the oscillator. Thus, if these are equal there will be a 45° phase displacement between grid and plate voltages which may be sufficient to cause serious trouble. Increasing the inductance of the choke coil reduces the difference in phase and is hence favorable for the prevention of blocking.

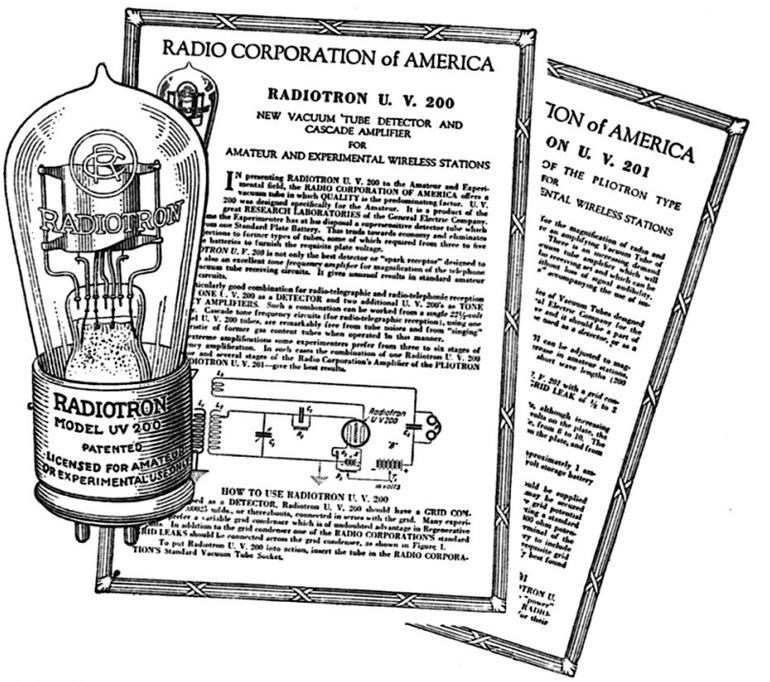
Another precaution which should be taken when the type of tube showing the blocking characteristic is used is to connect a high resistance between the secondary terminals of the speech transformer between grid and filament of the modulator. If this resistance is reduced below a certain value the tube cannot be made to block even with full voltage on the plate when the grid goes positive. With some tubes a hundred thousand ohms or so will suffice while with a certain type of tube with which the author is familiar the resistance must be reduced to only 6,000 ohms to prevent blocking on normal plate voltage.

The blocking phenomenon when present may be very serious endangering the tubes and badly distorting the speech. The two remedies, as first pointed out, are to increase the inductance of the constant current choke coil and shunt the grid-filament circuit with a high resistance.

TELL-TALE CONDITIONS IN OPERATING

Antenna Current. One of the most important criteria of operation of the constant current type of telefone circuit is the behavior of the antenna ammeter when talking. It is now generally understood that when the constant current system of modulation is used and is operating properly the antenna current alternately increases and decreases about the average steady value obtained when there is no speech impresst upon the modulator. For 100 per cent. modulation the current first reaches double its normal value and then falls to zero. Under such circumstances one's first impression might be that the antenna ammeter should read the same regardless of whether talking were going on or not. (See Fig. 15.) As a matter of fact, however, since the ammeter reads the effective (R. M. S.) current, it should go up when the microfone is spoken into, because the effective value of the modulated wave is greater than that of the unmodulated one. If the modulation is 100 per cent. upward and downward and is sinusoidal the antenna ammeter reading should increase 22½ per cent. For other percentages of sine modulation the percent. increase in antenna current is given in the following table:

Per cent. Modulation	*Per cent. Increase Antenna Current*
100%	22.5%
90	18.5
80	15.0
70	11.0
60	8.5
50	6.0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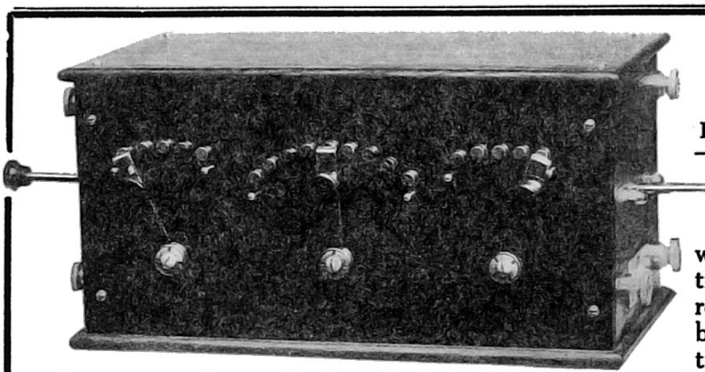

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A rough indication of how the set is operating and the amount of modulation present may therefore be had by singing a loud sustained note into the microfone and noting the change in the reading of the antenna ammeter. It is hardly possible to produce a pure sine wave from the throat so that the full 22½ per cent. increase in current is not to be expected. The current should, however, increase from 10 to 15 per cent. if everything is working right.

If the antenna current does not increase as it should, or if it remains steady, or decreases when talking, one or more of the following conditions may be suspected:

(a) Bias voltage on modulator grid too negative.

(b) Insufficient amplifier excitation.

(c) Detuning of master oscillator due to talking.

(d) Instability of master oscillator.

(a) In practical operation the bias voltage on the grid of the modulator will always be set somewhere relatively low on the bend of the characteristic curve. When the grid voltage is varied by talking, therefore, the plate current on the positive swing of grid voltage will increase much more than it decreases on the negative swing of grid voltage. If the bias voltage is too far negative the decreases in plate current may be insignificant in comparison with the large increases on the positive grid alternations so that the modulator practically does nothing but abstract power from the system on the average and the antenna output therefore falls. Such condition can be improved by using smaller grid bias on the modulator. It should be of interest to state, in this connection, that by using very small bias on the modulator or even none at all, the peak value of antenna current can be made to considerably exceed double the normal value. Such adjustment is not of course generally desirable since it is attended by distortion and overheating of the modulator.

(b) Insufficient amplifier excitation will cause a decrease in antenna current when talking and may generally be suspected when several tubes are used as amplifiers or the wave-length is long for the circuits used. The situation existing has been explained above under the heading "Amplifier Excitation."

(c) Detuning of the master oscillator due to talking: This is an effect which is very often present in circuits of the oscillator amplifier type and is generally more serious at short wave-lengths than at long ones and where the amplifier is a multiple tube unit. Its existence may be discovered by the following test. Leave the antenna tuning fixt and adjust the wave-length of the master oscillator circuit for maximum antenna current without talking. Upon talking, note that the antenna current does not increase, or even decrease slightly. Now overtune the master oscillator slightly; that is, increase the wave-length very slightly until the antenna current just begins to fall due to the mis-tuning. If the effect under discussion is present the antenna current will now fall very sharply upon talking into the microfone. As further evidence, undertune the master oscillator that is, shorten the wave-length to a value just below that giving maximum radiation without talking. If the effect under discussion is present the antenna current will now rise upon speaking into the microfone. The exact reason for these phenomena and remedial or corrective means for improving the conditions are subject matters of a patent application which cannot yet be disclosed. When present, however, it may be said that it is always best from the standpoint of effective output and quality of modulation to undertune the oscillator, as described, so as to secure an increase in antenna current when talking.

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(d) Instability of Oscillator: This is characterized by a sharp falling off of antenna current upon talking. It may or may not be accompanied by complete stalling of the oscillator. In any case a hot wire ammeter in the master oscillator circuit or an ammeter in the grid leak or in the d. c. plate lead of same will indicate the existence of the condition. None of these meters should show any variation when talking. If they do, the indications point to instability of the oscillator and the simplest procedure is to readjust the constants of its circuit.

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(*Continued from page* 517)

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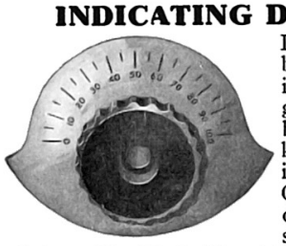

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Sparks and Spark Frequency

(Continued from page 523)

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Don't forget there is a limit to the speed. If we substitute a value for N, that is, give our gap such speed, that according to the formula, gives a result of greater power than we can actually put in, it simply means that the condenser will not charge sufficiently to produce a spark every time a rotary electrode passes a stationary, and a rough, uneven tone will result.

The curves of Fig. 1 should be of great value in the design of a transmitter. From them we can determine just what gap speed and how many electrodes will give highest power for given conditions. Suppose we have a quarter-K.W. with a 10,000 volt secondary. Follow the curve for 10,000 volts to the point where it passes 250 watts, our maximum input. We find that this corresponds to a spark frequency of 720. This means we must have a ten stud gap going at 4,320 r.p.m. or an eight stud gap going at 5,400 r.p.m.

In the same manner, you may find the best frequency for maximum operation of any of the transformers shown. If your voltage is not represented, or if you are using another size condenser a simple calculation from the formula will give your frequency.

From the curves we readily see that with the high voltages we have highest efficiency on 120-360 sparks, the favorite low note, while on the lower voltages highest efficiency is on the high static cutting frequencies. There may be variations in the actual spark frequency used, to suit special cases. A frequency slightly below the value given for full power, may give smooth operation because of the sparks taking place at more desirable intervals on the secondary 60-cycle current wave.

In conclusion, remember high secondary voltage, low note; low secondary voltage, high note. I hope this may be of help to those who want to "spread out" this season.

Club Gossip

(Continued from page 562)

RADIO CLUB OF FRANCE.

At the beginning of this year the Radio Club of France was formed in Paris, which was the first of its kind in that country. It was organized for the advantage of the amateurs interested in all branches of Radio.

The club house is equipt with a complete library, a laboratory and a large room where lectures with lantern slides are given quite often by radio engineers and members of the club.

The Radio Club of France will be glad to hear from American clubs and all correspondence should be addresst to the Secretary, 95 Rue de Monceau, Paris, France.

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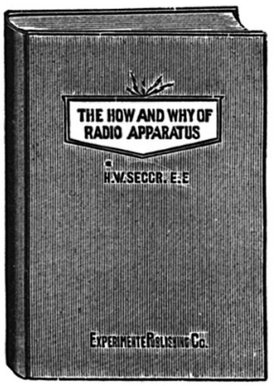

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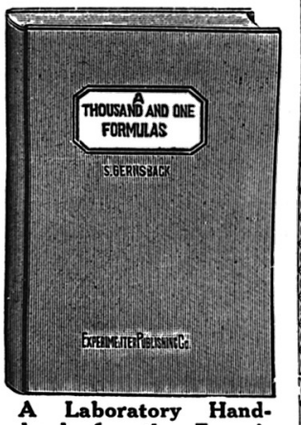

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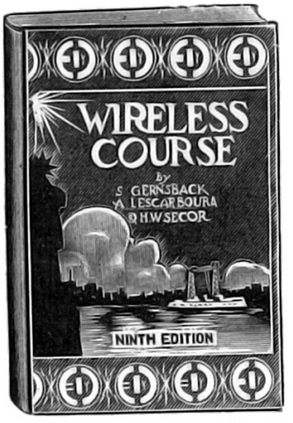

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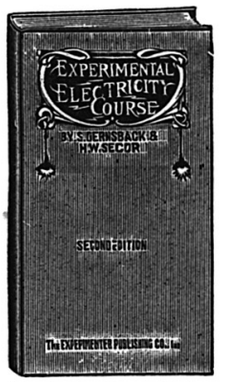

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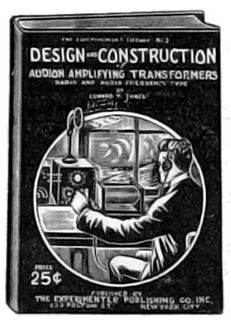

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(*Continued on page* 581)

(*Continued from page* 580)

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(*Wireless continued*)

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(*Wireless continued*)

Blue Prints—Twelve proven receiving circuits, each on separate sheet, all for 40c. Ten proven radio phone and two combination VT hookups for transmitting, 50c. Wireless code on large blue print 25c. The Plan Bureau, 1929 McCausland Ave., St. Louis, Mo.

State Panels for that set. Bases for honeycomb mounting switches, in fact any kind of panels or bases that the Radio bird desires. Special panel 16" x 6" x ½" sent p.p. for $2. State size and thickness in first letter. The Panel Shop, Box 16, Monson, Maine.

Build Your Own Variocoupler. Grey seamless cardboard tubes 4⅞" diameter, 4½" long and 3⅞" diameter 2" long are ideal sizes for building it. Mailed postpaid for 35c. per set. Order today. The Taylor Company, Box 1043B, Lowell, Mass.

CW Units, variocouplers, bakelite construction, $6; variometers, inside windings, $5; oak cabinets, all sizes, with or without bakelite panels, VT control units, series-parallel panel switch, 50c. Mead Bakelite Radio Apparatus, 975 Putnam Ave., Brooklyn, N. Y.

W. E. Carbon Cup Transmitters used by U. S. Signal Corps, 60c; tel. jack and plug with cord, 65c; standard 11 ohm porcelain rheostat, 55c.; postage extra on all goods; immediate refund if not satisfied. Send for catalog. Haupt Elec. Supply Co., 2442 Ogden Ave., Chicago, Ill.

Phone Transmitters for VT sets, $1.50 postpaid. Rare bargain, only a few. Act quick. T. P. Hagerman, 1929 McCausland Ave., St. Louis, Mo.

Build Your Own Variometer. Let us send you tubes for winding it. Fine grey seamless, cardboard tubes 4⅞" diameter, 2½" long and 3⅞" diameter 2" long. Ideal sizes. Thousands in use. Mailed postpaid for 25c per set. Order today. The Taylor Company, Box 1043B, Lowell, Mass.

Grid Condensers prepaid anywhere, 50c each. Ingenious invention makes it possible to hermetically seal very small capacitances in very small compartments. Not exposed to changes of atmosphere. 100% efficiency performance test. Works with any type tube. Crescent City Radio Company, Dept. D., P. O. Box 1104, New Orleans, La.

5,000 Six Volt Miniature Lamps Sacraficed. Must sell out immediately at extremely low price of ten cents each. P. O. Box 1104, New Orleans, Louisiana.

Experimental Electricity Course in 20 Lessons. By S. Gernsback and H. W. Secor, E. E. A course of the theory and practice of Electricty for the Experimenter. Every phase of experimental electricity is treated comprehensively in plain English. New experiments are described and explained and nearly every application of Electricity in modern life is given. 160 pages—400 illustrations. Flexible cloth cover, 75c postpaid. Stiff cloth cover, $1.25 postpaid. Experimenter Publishing Co., Book Dept., 236-A Fulton Street, New York.

Just Off the Press. Design and Construction of Audion Amplifying Transformers (Radio and Audio-Frequency Types). By Edward T. Jones, late Associate Editor Radio Amateur News. The transformers shown in this book have never been described in print before and have usually been considered a manufacturer's secret. The designs are very rugged and simple. A book that every radio "bug" should have. Writen so you will understand every word. Price 25c postpaid. Experimenter Publishing Co., Book Dept., 236-A Fulton St., New York City.

The How and Why of Radio Apparatus, by H. W. Secor, E. E. This newest book on radio matters fulfills a distinct gap in wireless literature in that, while the treatment is made as understandable and as free from mathematics as possible, it at the same time incorporates a wealth of teachnique and instruction for the Radio Amateur—the Radio Operator—the Installation and Designing Expert—as well as teachers and students of the subject in general. A very broad field has been covered by the author, at the same time giving a great deal of information not found in other text books. If you are engaged in any branch of the Radio or allied arts at all, you will surely need this latest contribution to radio literature, which is destined to be found on every radio man's book shelf before long. A glance at the following list of chapters gives but a very scant idea of the extensive and useful radio knowledge provided in its text: The Induction Coil; The Alternating Current Transformer; Radio Transmitting Condensers; The Spark-Gaps; Radio-Transmitting Inductances; Radio Receiving Tuners; Radio Receiving Coudensers; Detectors; Telephone Receivers; Radio Amplifiers; Construction of a Direct Reading Wavemeter and Decremeter; Antenna Construction; The Calculation and Measurement of Inductances; Appendix containing very useful tables, covering all subjects treated in this very unusual book. This newest of Radio Works, cloth bound in Velum de luxe, Gold stampt and Hand Sewed, has 160 pages. Size of book 6x9 inches. "The How and Why of Radio Apparatus," postpaid, $1.75. Experimenter Publishing Co., Book Dept., 236A Fulton St., New York City.

(*Continued on page* 582)

(*Continued from page* 581)

Wanted to Buy

Send to Cleveland by mail or express any old or broken watches, false teeth, old or broken jewelry, brooches, bracelets, old gold, silver, platinum, diamonds, magneto points, platinum wire, contact points or crucibles, mercury, and anything valuable. We pay the highest prices in cash by return mail. Goods returned in ten days if you're not satisfied. The Ohio Smelting & Refining Company, 207 Lennox Bldg., Cleveland, Ohio.

Exchange.

Sale, $85.—One kilowatt X-ray transformer, sell, $25. L. Windom, 1375 Franklin Ave., Columbus, Ohio.

Bridges, Used—38 coils, 10 to 4,000 ohms, $6.50, measure resistance and capacity yourself. 2,000 ohm relays, $3; plugs, 50c. Following, new: closed and open circuit jacks, 50c. Fahnestock phone connection blocks, 20c; bakelite knob with pointer, 15c. Postage extra. Western Instrument Repair, 314 N. Fairfield, Chicago, Ill.

Sacrifice—Robbins & Myers rotary gap motor, 2,000 to 8,000 revolutions per minute, variable speed, reversible, 110 volt, A.C. or D.C.; new, cost $15; this motor, somewhat out of condition, but will run, $5. Write immediately. Francis H. Tratt, 705 Main St., Whitewater, Wis.

Sell—DeForest receiving set, geared coil mounting, condensers on unit panels, ¾ inch spark coil, wireless course, $15. Send stamp, R. Wm. Tanner, General Delivery, Bridgeport, Conn.

Will Sell Complete loose coupler, receiving set, with bulb and crystal detectors, cheap. Write. Walter Scholz, La Crosse, Wash.

For Sale—Corona typewriter in traveling case, used six months, $30. Rollin H. Stewart, 3023 Boulevard Place, Indianapolis, Ind.

New Storage Batteries, 6V 50A, $15; 6V 60A, $20; 6V 120A, $35; 12V 50A, $30; DeForest two-step amplifier, $46; Baldwin phones, $10; ¼ K.W. rotary converter, $30. F. J. Suchanek, 1400 Ave. A, New York City.

Let's Swap Buy! Sell! What'ye got? Whatd'ye want? Dime quarterly. Swap Bulletin, New York—Detroit.

For Sale or Trade—15 inch induction coil cabinet, mounted, with ammeter 0-25 voltmeter 0-125, Wehnelt interrupter (bad anode). Can be used for X-ray, violet ray or radio experiments, gives 500 cycles on 110 volts D.C. M. Siebert, 119 50th St., Corona, Long Island City, N. Y.

For Sale—Receiving apparatus. Write for list. Henry Schrier, 1127 S. Park St., Kalamazoo, Michigan.

For Sale—Radio and Electrical apparatus. New and slightly used. Prepaid. Communicate with Walter Soderman, Aitkin, Minn.

For Sale—Loose coupler, $5. New Jove detector with crystal, $1.50. Roger Shaw, Concord, Mass.

Sell—15 dial omnigraph, new, Christmas; Westinghouse ⅛ H.P. D.C. motor. Rust, E. State St., Ithaca, N. Y.

Complete Panel Receiving Set, phones, battery, bulb, etc, $35. Write for description. Ridge Radio Co., Park Ridge, Illinois.

For Sale—Complete DeForest 12 panels with panel board, Holtzer-Cabot phones and 200 feet aerial wire, $60. Panels, board, $50. Andrew Potter, 213 Westminster Ave., Syracuse, N. Y.

Sale—One variometer type regenerative receiver, $30. Also complete set parts including assembled variometer, $20. Two stage amplifier, $28. Two K.W. 15,000 volt transformer, $25. Samuel Place, 622 Stanbridge St., Norristown, Pa.

For Sale—Clapp-Eastham 1,500 meter loading coil, $3.25 postpaid. Auto starting motor, 6 volt D.C. A powerful boy. $8 F. O. B. Frank Peterson, Muscoda, Wis.

Exchange—Indian bicycle, cost $70, for a short wave regenerative receiver and a storage battery. Chas. Peterson, 2727 So. Sheridian St., South Philadelphia, Pa.

5 Dial Omnigraph, $12. $10 Bunnel straight line radio key, $5. Small complete set $5. Philip Orein, 54 Cook St., Brooklyn, N. Y.

Navy Type Coupler, cost $20; sell, $14. DeForest audion cabinet, cost $14.25, sell $11. Unit panels. All new. Emanuel Nyman, 525 W. 160th St., New York City.

Wanted—¼ H.P. motor, 110 volts A.C. D. Nelson, 403 Beacon St., Lowell, Mass.

For Sale—Two large 43 plate condensers (.0015) in glass cases. Price $4.50 each. Radioson detector $4. Dustproof Galena detector $2. Fixed variable condenser $1. All for $15. Daryl McClung, 1221 Ninth Ave., Huntington, W. Va.

Quitting Radio—Will sacrifice magnificent receiver, described page 355 December "Radio News" in fine shipping chest, complete coils, no tubes, only $94. Thirty dollars with order, balance C. O. D. Volney Mathison, 1411 Castro St., Oakland, California.

(*Exchange continued*)

Audion Panel Complete, $18.75; Arlington coupler, $7.50; laboratory variable condenser, $5.00; ground switch, $3.75; all new. Robert McCracken, 46 South Third, Cuyahoga Falls, Ohio.

For Sale—Holtzer-Cabot phones, $6; Arnold coupler, 3,000 M., $14; Murdock coupler (new), $7.50; Clapp-Eastham coupler, $10; Radio Service audion panel, $5; 43 plate V. Con., $2; 2 fond. spark coils, 75c each. DeForest crystal det., $1.50. Chas. N. MacPherson, 98 Spencer Ave., Lynbrook, L. I., N. Y.

Sell—Radio and electrical appartus. Write. Markham, 521 N. Second, Saginaw, Mich.

Sell—One K.W. Amrad quenched gap and resistance for same. Guaranteed good as new. Edwin Moore, 309 Sherman St., Joliet, Ill.

Bargain—First $30 money order take these two cabinets: 4,300 meter receiving and one mile transmitting. Both practically new. Must sell. M. R. Long, Rainier, Oregon.

For Sale—Murdock .001 mfd. condenser (interior), $2.75; Marconi VT 1 used about 100 hours, $5.50, cash. Rubert Lewis, 625 S. Church, Princeton, Ill.

For Sale—¼ K.W. wireless transmitting set without key, buy parts. Also repaired audiotron cheap. Norbert Leach, 1205 Rialto Ave., San Bernardino, California.

Wanted—Omnigraph in good condition. State lowest price. Louis C. King, 2933 Washington St., Wilmington, Delaware.

For Sale—Two .001 mfd. Murdock variable condensers unmounted, $4 each; navy type, 4,000 meter loose coupler, $16; aerial switch, $3.50; Western Electric service telephone, $7. Detector fitted with inverted tube receptacle, rheostat, potentiometer, phone jack, A and B battery switches, resistance and grid condenser, bakelite panel size 3-16" x 11" x 16" with space for mounting filament ammeter and two variable condensers, also two navy dials and knobs included, $20. Everything sacrificed. For particulars address R. L. Lennart, Hamburg, Pa.

For Sale—Laboratory step down transformer in finished oak cabinet. All controls including meters on black fibre panel engraved with white letters. Transformer windings in steel case. Input 110 volts 60 cycles. Output variable ¼ 115 volts A.C. and includes D.C. rectifying bulb for currents up to 10 amperes. Will light audions, charge storage batterys, electro-plate and control A.C. motors up to 1-10 H.P. Highly finished throughout. Price $90. Write Lloyde V. Berkner, 117 Summit St., Sleepy Eye, Minnesota.

For Sale—Short wave regenerative receiver, $20; audion control panel, $12.50; variable condenser, $2; 5 volume set automobile engineering, $16.50. Perfect condition. Write for list. R. L. Kunau, Sabula, Iowa.

Sell—Wireless set made up of 3,000 ohm Murdock phones, 3,500 meter loose coupler, fixed condenser, small detector, variable condenser, and a few other things. First money order for $17.50 takes it; parcel post charges collect. Judge, 151 West 1st St., Salida, Colorado.

Buy or Sell—You can do either just by sending us names of articles. 10c each article per month. We send you names of persons wanting to buy or sell these articles twice monthly. Let us convince you. International Advertising Agency, 1307 Chartres St., Houston, Texas.

Will Exchange a complete Chem. "lab." includes a sensitive balance and weights, for wireless apparatus or $60. Write for description. H. Isaacson, 900 Riverside Drive, New York.

For Sale—Ace type T.T. regenerative tuner 150-2,500 meters, and home-made audion control cabinet with bulb and B batteries and Brandes navy type phones. Complete, $70. H. Halvorson, 513 4th St., S. E., Watertown, S. Dak.

Wanted—Receiving set with sensitive relay and standard recorder to record Arlington time anywhere in U. S. This set must be well made and work reliable with a minimum antenna space, also should be compact and supplied with storage battery, standards, V.T. and antenna materials. Give full particulars and price in your first letter. H. Haefliger, 107 Kirkwood Hotel, Des Moines, Ia.

Exchange—Mignon U.W. 1 undamped tuner, 35; 1 BD1 detector, $15; both $47.50; 1 Tresco long wave tuner, $5; 1 DeForest SCR 54, short wave tuner, $3.50; 2 .0005 DeForest variables, $2.50 each; 1 rheostat, $1; 2 1½ switches, 75c each; 1 meteor 43 plate variable, $2.50. What have you? E. F. Key, Charleston, Wash.

For Sale—DeForest ULC 100, $8; ULC 300, $4; coils L25, 2L50, L100, 2L150, L200, 2L250, 2L400, $18; detector D101, $1.50; $28 takes it all. All the apparatus in perfect condition. Address Homer Hatch, Plano, Ill.

For Sale—Used auto generators suitable for battery charging or experiment, 6 and 12 volts, perfect condition. Reasonable prices. Enclose stamp for particulars. Lynn Goodnough, 44 Lydia St., Binghamton, N. Y.

New Sears-Roebuck navy coupler, $14. Write Whitney Gillilland, Glenwood, Ia.

(*Exchange continued*)

Variometers $5.—6,000 meter navy loose coupler. $10. Two stage amplifier with detector, $50. 700 meter regenerator, $30. Want transmitter bulbs. Wm. Govern, Edwardsville, Penna.

For Sale—Navy type receiving transformer, $18; E. I. Co. "government" phones, $7; audion-Ultraudion control panel, $9; 800 ft. antenium aerial wire, 60c per 100 ft.; 100 ampere 600 volt lightning switch, $3.50; E. I. Co. chemical laboratory, never used, $5; 12 high grade glass chemical beakers, all sizes, cheap. Address Lloyde V. Berkner, 117 Summit St., Sleepy Eye, Minnesota.

Will Sell one pair 2,000w French army phones complete, $8; one pair 4,000w French army phones without band, $6; transformer from French 3ter amplifier, excellent, $6; double element tubular rectifying bulb, $5; Yale frame and tank without fork $5; last model Yale two-speed clutch, $8; canoe paddle, $2; half-h.p. horizontal steam engine, worth double, $50; express collect and mail prepaid. Offer me trades in the line of 1 k.w. sending apparatus, transformer, OS transformer condenser, switches, gaps, etc. L. E. Felker, Madison, Maine.

Lightning Switch, $3; control panel with bulb, $10; half kilowatt key, $3; Galena set, $3; DeForest detector, $1.50; also other apparatus. James Zimmer, Lynbrook, New York.

For Sale—F-F magnetic rectifier, Arnold coupler, three sections Murdock sending condenser, new audiotron. Bud Hartmann, 73 Liberty St., Meriden, Conn.

For Sale—Half-kilowatt Thordarson, $14; 4 sections. Murdock, $7.50; oscillation transformer, $3.50; Amrad wavemeter, $5; Amrad quenched gap, never used, $17; hot wire, $6; antenna switch, $2.50; Electrose lead in, $3.50; kick-back preventer, $3.50; Eveready 6 volt, $14; lightning switch, $2.50; 100 feet, $2; copper, $7.50; 10 Electrose antenna insulators, $3.50. Chas. MacCarron, 250 Radde St., Long Island City, N. Y.

Attention—Amateurs—Complete audion detector and two stage amplifier, 12-unit panel, with four variable condensers, 3-coil mounting, amplifying transformers, jacks, plug, etc., all mounted and wired ready to use. No coils, batteries, bulbs, or phones. Worth $125; first check for $63.25 takes it, express prepaid. Want one K.W. transformer. Charles Daly, 824 E. Platte, Colorado Springs, Colorado.

For Sale—Two-stage amplifiers with cabinet and B batteries, $50; with detector, $65. A. Greenberg, R. 2, Hackensack, N. J.

Exchange Bureau—Get listed, send details, no charge. We forward the address of parties who want what you have or have what you want. Also cash deals. Negotiate then pay dime. McDonnells, 1612 Sedgwick St., Pittsburgh, Pa.

Sell—15 dials omnigraph with buzzer, key and single phone. N. G. Rehnstrom, 230 East 84th St., New York City.

C.W.—Complete ½ K.W. arc phone set for sale. Consists of radiation meter, oscillation transformer, arc, condenser, microphone, rheostat and choke coil, works on 110 D.C., mounted on bakelite panel. Description and photos on request. Terms $50 C. O. D.; cash back guarantee. E. Brown, 301 College Ave., Ithaca, N. Y.

For Sale—110 volt motor, good for rotary, $4.50; Murdock 43 plate condenser, $2; Marconi socket, 75c; Victor phonograph, $10; Mesco key with large contacts, $2.50. Write to H. Van Dohlin, 348 W. 36th St., New York City.

For Sale—Complete receiving outfit, VT detector and amplifier with "B" batteries. VT tubes, honeycomb coils with pedestal mounting, Meteor 3,200 ohm phones, Baldwin type E phones, storage battery and other instruments. Earl H. Miller, 614 Grace St., Williamsport, Pa.

For Sale Cheap—Several good sending instruments. What have you? Lester Fawcett, Janesville, Wis.

Bargains—3,500 meter loose coupler, $8; audiotron cabinet bulb, $15; set of 3 loading inductances, $15; detector, $1.50; Meccano motor, reversible, $2.75; big electric track, $2.25. Jacob Eder, Aurora, Ill.

For Sale—Audion receiving outfit, mounted on bakelite panel, oak cabinet, has been used two months. Guaranteed first class condition; cost $60; sell for $40. Jas H. Elder, Marshall, Ind.

Bargain—½ K.W. Thordarson transformer, Murdock O.T. rotary gap, oil condenser, panel mounted, $45. Jack DeLorme, 235 Menomonee St., Chicago.

For Sale—One CR-2 Grebe receiving set, two months old. Am installing lone wave receiver. Wm. J. Callahan, 158 9th St., L. I. C., N. Y.

Bargains—One Murdock receiving transformer, $6.50; 1 Murdock 43 plate variable condenser, $4; 1 Robbins & Myers 110 volt A.C. motor (for motor generator), $18; 1 audiotron (double fil.) with panel fixtures, $9; 1 each No. 200, No. 100 and No. 25 DeForest Honeycomb Coils, 35% off. Used about two months and in A No. 1 condition. Wayne Caton, Clarksville, Texas.

(*Continued on page* 583)

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(*Continued from page* 582)

(*Exchange continued*)

1,500 Mile Receiving Set, complete, $25; also switches, motors, etc. All letters answered. Alva Flippin, Rainier, Oregon.

Sell or Exchange for radio apparatus, McGraw-Hill Machine Shop Course, never used. Cunningham, 280 East 155th St., New York.

For Sale—Wireless apparatus audion, loose coupler, etc. For information phone Chelsea 5944, Leonard Beck.

For Sale—Camera, 4 x 5 Premo No. 8. Write to Arthur Bryn, Devil's Lake, North Dakota.

For Sale—15 panel DeForest unit set, perfect condition, 2 stage-amplifier, finely finished backboard. Gets foreign ARC and DX200 on indoor antenna. Price reasonable. Write. Frank Bryant, 778 Main St., Worcester, Mass.

Bargain—Paragon regenerative tuner, 20,000 volt oil condenser; rotary disc, step-down transformer and erector No. 6. P. Barrett, 222 N. Dunn St., Bloomington, Ind.

For Sale—A high grade beginner's cabinet receiving set, made to order. Has a "Tewno" bank-wound coupler, DeForest galena and Marconi carborundum detectors, Murdock .001 variable condenser, potentiometer and buzzer test, etc., mounted in a portable hardwood cabinet. Bargain, $30; 5c (stamps) for photograph. Letters answered. E. G. Baier, 253 Ninth St., Brooklyn, N. Y.

Bargain—Brand new Tungar rectifier, 6 cell, 6 amp. charging rate, for 115 volt, 60 cycle current. Cost $32; complete with bulb, directions and 12-ft. cord; sacrifice at $26. D. Burnham, 35 Commonwealth Ave., Springfield, Mass.

For Sale—Radiophone 500V.-250W. generator. C. Brewer, 185 Harker St., Mansfield, Ohio.

Exchange or Sell old type Disco electric Ford starter and generator, fair condition; 20,000 M. C. W. tuner, never used, $6; 2 slightly used storage batteries, 1 4V. 50A., $12; 1 4V. 40A., $10; both are in excellent condition; 2 44V. variable "B" batteries, never used, $2.50 each. Want Grebe two-step amplifier or good regenerative set. Galen Baker, Clay City, Indiana.

Wanted—Small 110 to 500V. 120 or 240 cycle generator. State condition. W. T. Alstead, 617 Western Ave., Topeka, Kansas.

For Sale—Complete receiving panel and two step amplifier, including set of honeycomb coils and bulbs. Apparatus guaranteed. Write for full description. Also key, rheostats, Murdock and Brandes phones, receiving transformer, etc. Earl Atkinson, 1301 University Ave., Urbana, Illinois.

Big Offer—Phones, ammeters, keys, transformers, etc., at great reductions. List on request. Nathan Sameth, 240 Varet St., Brooklyn, N. Y.

Trans-Atlantic 3,000 ohm phones, $10; Solar bicycle light, $2.50; aluminum canteen (5 pieces), $2.50; tel. sounder, $1.50; new set of taps and dies, $1.50. Guaranteed in good condition. Alva Flippin, Rainier, Oregon.

New Amrad Induction Coil outfit complete, $35. Cr-3, $45; 350 volt motor generator, $80; 15 panel DeForest unit set complete with bulbs and varniers. Prescott Smith, 35 N. Maple Ave., Ridgewood, New Jersey.

Exchange—New auto knitter. Also No. 3 camera and outfit for wireless receiving set. Wade Griffin, Portland, Tenn.

Wanted—Western Electric loud speaker with or without transformer. Albert J. Higson, 84 Romaine Ave., Jersey City, N. J.

Trade—Have $75 Howard R-A watch, new. Want wireless receiving set. No junk. What have you. L. L. Davenport, 547 East 7th St., North, Portland, Ore.

For Sale—4,500 meter navy type loose coupler, excellent condition; price, $18. J. W. Weaver, 1326 Leighton Ave., Anniston, Ala.

Bargain—Receiving cabinet and audion ultra-audion cabinet, $35; navy phones, $10; lightning switch and 30 feet ground wire, $8; D.C. fan motor, $10; Murdock transmitting condenser, $2; new key, $2; gap, 50c. Almost all worth double. Cohen, 248 East 121st St., New York.

New $60 DeForest radiophone transmitting bulb and panel; new $27.50 General Radio wavemeter; new $10 aerial ammeter; 1,000 feet new 42-strand phosphor bronze aerial wire, cost 5c per foot; condensers, grounding switch and other apparatus. Sell for one half cost. 120 Christie St., Ridgefield Park, N. J.

Amateurs—Write for my list on new and used radio goods, including complete sets couplers, transformers, etc. Chas. F. Goodley, 811 Shipby St., Wilmington, Del.

THE BEST—at Prices That Save You at Least 20%

	Each
Binding Posts, brass	$ .05
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Helix Clips for round wire	.18
"B" Batteries	1.20
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Variable Condensers, unmounted, 21 plate	3.28
Variable Condenser, unmounted, 43 plate	3.85
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Switch Units, complete, large	.55
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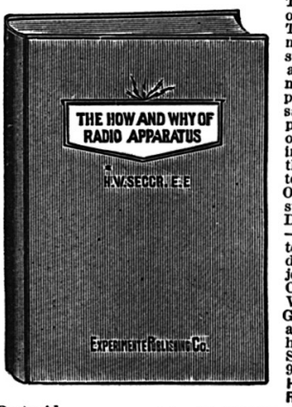

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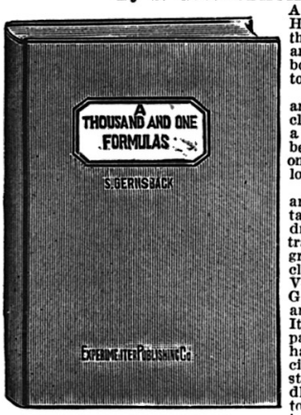

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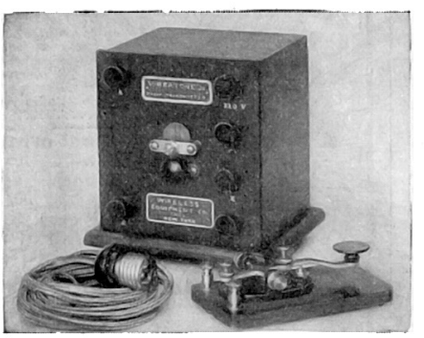

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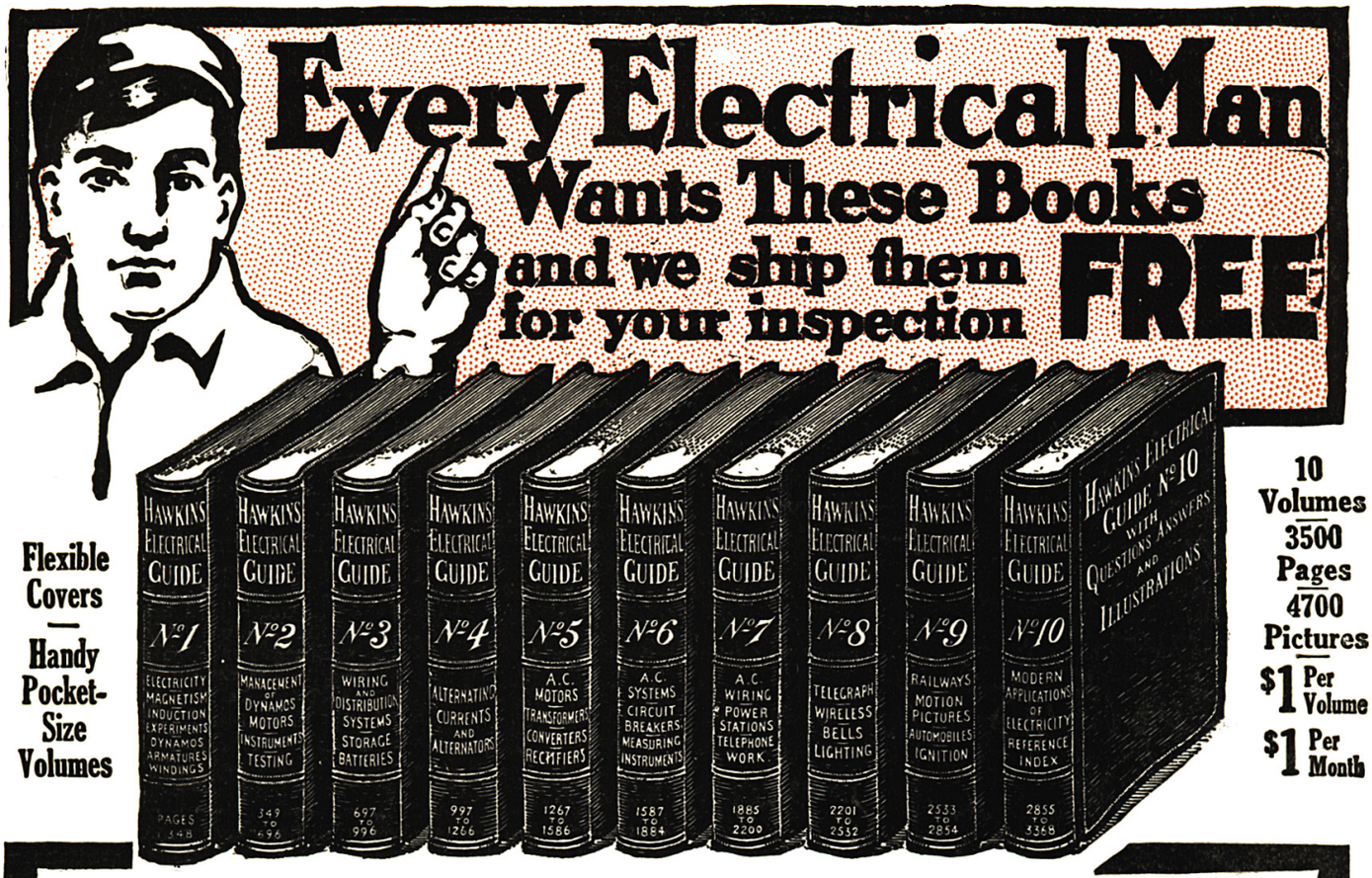
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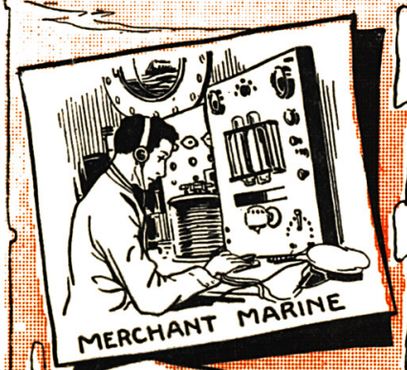

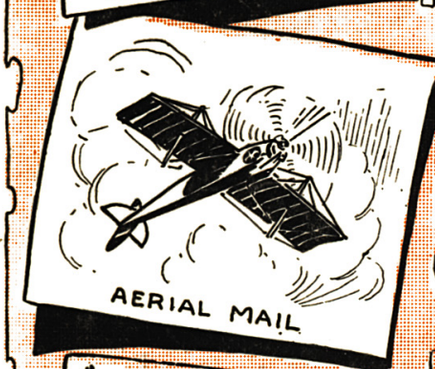

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